U.S. DEPARTMENT OF COMMERCE
National Technical Information Service

PB-282 312

Effluent Monitoring Procedures: Basic Laboratory Skills Staff Guide

Charles County Community Coll, La Plata, Md

Prepared for

Environmental Protection Agency, Cincinnati, Ohio Office of Water Program Operations

May 78

EPA-430/1-78-005

PB 282 312

EFFLUENT MONITORING PROCEDURES: BASIC LABORATORY SKILLS

STAFF GUIDE

U.S. ENVIRONMENTAL PROTECTION AGENCY

OFFICE OF WATER PROGRAM OPERATIONS

REPRODUCED BY
NATIONAL TECHNICAL
INFORMATION SERVICE
U. S. DEPARTMENT OF COMMERCE
SPRINGFIELD, VA. 22161

TECHNICAL REPORT DATA
(Please read Instruc ons on the reverse before completing)

1. REPORT NO. EPA-430/1-78-005	2.	3. RECIPIENT'S ACCESSION NO. PB282312
4. TITLE AND SUBTITLE Effluent Monitoring Procedures: Basic Laboratory Skills Staff Guide		5. REPORT DATE May 1978 (date of issue) 6. PERFORMING ORGANIZATION CODE
7. AUTHOR(S) David M. Wagner, William T. Engel, John H. Highby		8. PERFORMING ORGANIZATION REPORT NO.
9. PERFORMING ORGANIZATION NAME AND ADDRESS Charles County Community College P.O. Box 910 La Plata, Maryland 20646		10. PROGRAM ELEMENT NO. 11. CONTRACT/GRANT NO.
12. SPONSORING AGENCY NAME AND ADDRESS National Training & Operational Technology Center Municinal Operations & Training Division, WPO Environmental Protection Agency Cincinnati, Ohio 45268		13. TYPE OF REPORT AND PERIOD COVERED 14. SPONSORING AGENCY CODE 700/02

15. SUPPLEMENTARY NOTES

Supercedes EPA-430/1-75-008

16. ABSTRACT

This manual is designed for use by instructors who will have to teach others basic laboratory skills needed to perform National Pollutant Discharge Elimination System (NPDES) analyses. It is to be used in conjunction with the Student Reference Manual bearing the same title (EPA-430/1-77-011). It includes topics related to the presentation of training courses in which the NPDES analyses would be taught. These topics include examples of course announcements, course agenda, and course certificates; consideration of training staff, training facilities, course records, and registration procedures. Also included are Instructional Package Worksheets (lesson plans) giving details relative to presenting instruction regarding each of the basic laboratory skills covered in the associated Student Reference Manual.

17. KEY WORDS AND DOCUMENT ANALYSIS

a. DESCRIPTORS	b. IDENTIFIERS/OPEN ENDED TERMS	c. COSATI Field/Group
Mathematics, metric system, measurement, laboratory equipment, chemical compounds, weight indicators, solutions, volumetric analysis, agents, bacteria, effluents, experimental data, microbiology, education, specialized training, engineering education, industrial training, training devices	Effluent monitoring procedures, chemical laboratory skills, national pollutant discharge elimination system	06-A, 07-B 13-B 14-B

18. DISTRIBUTION STATEMENT Release to public	19. SECURITY CLASS *(This Report)* Unclassified	21. NO. OF PAGES 211
	20. SECURITY CLASS *(This page)* Unclassified	22. PRICE A10 - A01

EPA Form 2220-1 (9-73)

EPA-430/1-78-005
April 1978

STAFF GUIDE
for
CONDUCTING THE COURSE

EFFLUENT MONITORING PROCEDURES: BASIC LABORATORY SKILLS

National Training and Operational Technology Center
Municipal Operations and Training Division
Office of Water Program Operations
U.S. Environmental Protection Agency

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Awarded To:

Charles County Community College
La Plata, Maryland

Project Funded By:

Manpower Development Staff
Office of Water Program Operations
U.S. Environmental Protection Agency

Grant No. 900501

Project Director:

Carl M. Schwing

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PREFACE

TO THE USER OF THIS MANUAL

Background of Effluent Self-Monitoring Requirement

With passage of the Federal Water Pollution Control Act Amendments of 1972 (Public Law 92-500), a new permit program was created to replace and improve upon the earlier permit system which existed under the 1899 Refuse Act.

Under the 1972 Act, the United States Environmental Protection Agency is required to establish national effluent limitations and national treatment performance standards for all sources of water pollution, including not only municipal discharges but also factories, animal feedlots, and power plants. These effluent limitations are the maximum amount of a pollutant that any discharger may release into a water body.

In order to insure that the prescribed effluent limits are met, every discharger is required to obtain an NPDES (National Pollutant Discharge Elimination System) Permit. Types of water discharge sources for which a permit is required include municipal wastewater treatment facilities; manufacturing plants; agriculture, forestry, mining and fishing operations; and other service, wholesale, retail, and commercial establishments having operations which result in discharge of water to the Nation's bodies of water.

The NPDES Permit is not a license to pollute. To the contrary, a Permit stipulates what may be discharged and how much may be discharged over a defined period of time. Each Permit is tailored to the discharger and sets specific limits on each effluent.

Furthermore, the NPDES Permit also requires dischargers to monitor their effluents, performing specified tests and measurements at designated frequencies specified in the individual Permit, and to report the amount and nature of all waste components discharged.

Training Need Associated with Self-Monitoring Requirements

Compliance with NPDES requires that all specified tests and measurements be performed in accordance with methods specified by EPA and announced in the Federal Register. Only under very limited conditions are deviations from specified methods acceptable.

These requirements are the basis of an immediate, massive, training need to provide the responsible waste water treatment personnel with the knowledge and skills required to comply with the self-monitoring requirement. There is at present a wide range of initial capabilities for performing the tests and measurements. This ranges from the situation in the large, fully-staffed, fully-equipped facility in which little or no training is required, through all shades and levels to the limited staff in small, inadequately-equipped facilities in which at present there is little or no capability for performing the required tests and measurements.

This is one of several special short-term courses recently developed and currently under development by the Environmental Protection Agency and associated educational institutions. This Instructor's Guide is intended to assist other training organizations in conducting training of waste water treatment plant operational personnel in the tests, measurements, and report preparation required for compliance with their NPDES Permits.

TRAINING AVAILABLE OR UNDER DEVELOPMENT TO MEET SELF-MONITORING REQUIREMENTS

Title	Workers should take this who:
Effluent Monitoring Procedures: Basic Laboratory Skills	Have little or no laboratory experience or training and need to develop basic skills, including use of balances; preparation of solutions and reagents; names, characteristics, preparation and care of common laboratory equipment supplies. This course prepares students requiring such training for entry into the following named courses in which procedures for designated tests and measurements are learned.
Self-Monitoring Procedures: Basic Parameters for Municipal Effluents	Have basic laboratory skills, as designated above, but need to learn one or more of the procedures required for most or all municipal effluents including BOD, fecal coliform, pH, suspended solids, flow, and reporting of results.
Effluent Monitoring Procedures: Metals Analyses	Usually have completed the "Basic Parameters" course but have a Permit which requires report on one or more metals.
Effluent Monitoring Procedures: Nutrients	Usually have completed the "Basic Parameters" course but have a Permit which requires periodic report on one or more of the so-called "nutrients" including nitrogen and phosphorus.
Effluent Monitoring Procedures: Flow Measurement and Sampling	Have made arrangements whereby the required laboratory procedures are performed elsewhere by contract or other special arrangement, and who are required only to collect and care for samples, and to make such tests and measurements as must be made at the sampling site.
Any of the analytical courses of EPA National Training and Operational Technology Center for specific Permits	Are professional chemists, microbiologists, or key laboratory technicians in large treatment facilities where they work full-time doing a designated series of analytical tests and measurements.

A Personal Note to the User of this Guide

The need for providing this training, and the nature of current efforts of the Environmental Protection Agency to meet this need have been discussed in foregoing paragraphs.

It is an oversimplification of a classic quotation to say that all that is needed to conduct training is to "put Mark Hopkins on one end of a log and a student on the other." It is almost as much an oversimplification to say that all that is needed to conduct a course is to bring together the students and the instructional staff in a classroom and laboratory equipped with requisite equipment and supplies for the instruction to be delivered.

A short course such as this involving both classroom instruction and laboratory application and requiring critical learning outcomes to be achieved within a limited period of time, needs careful, detailed planning, preparation, and implementation. Meticulous attention to detail and effective staff teamwork are essential at every step of course planning, development, and implementation.

The purpose of this Staff Guide is to provide you, the training staff member, with useful, practical assistance in presenting this course in your own facilities. The Guide is a resource. It is not a blueprint to be followed ridgidly or unthinkingly. Even with this guide or any other form of assistance, you will have to plan, to think and to prepare in order to perform effectively in conducting this course. On the other hand, this Guide should be helpful in reducing the amount of original development work you will have to do, and it should be helpful in suggesting factors in course planning and presentation which otherwise might be ignored or glossed over.

You are invited, in fact requested, to participate actively in making this Guide a living document which effectively represents the best experience of all in planning, preparing for, conducting and terminating this course. Please provide this office with your constructive suggestions for strengthening and improving upon this Guide, based on your own experiences in conducting the course. Your recommendations will be fully considered in future editions of this and other Staff Guides for other courses of this series. In the event that questions arise in interpretation of any aspect of this Instructor's Guide, please write or call:

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Format of this Manual

This manual consists of two major parts. Part I is concerned with administrative aspects of planning, preparing, and conducting the course. Part II consists of guidance to the instructional staff on the technical content, learning objectives to be achieved by the students, and lesson-by-lesson instructional guides for each of the several self-monitoring procedures covered in this course.

Part I, which immediately follows, will have greatest value to those conducting this course for the first time or for the first few times. With practice in conducting the training most organizations will develop their own adaptations and ramifications of this plan to meet their own requirements and the specific situation.

It is strongly urged that each institution conducting this training course develop its own formal version of such a guide as this. Staff does change; new personnel require indoctrination and training on standard procedures of the organization they have joined. Rules and procedures promulgated by regulatory authority do change; such changes will require adjustment in course content. With repetition of specified tasks, many staff members, however dedicated, do slip into unconscious variations in practice or omissions in details which can subtly change the character of the course. A formal plan and guide, consciously studied and followed, can help the training instructor and the administrator to avoid many pitfalls.

Intelligent use of a plan such as this, with variations as proven necessary, can go far in keeping this course in harmony with the needs of the students and with requirements of regulatory authorities. Above all, the course should remain free of the distractions and last-minute corrections of errors or omissions discovered at untimely stages in course preparation and presentation.

PART I - COURSE PLANNING AND MANAGEMENT

A. Course Plan and Working Schedules

This section considers five topics:

Responsibilities in self-monitoring training

It is an inherent responsibility of any teacher to provide a learning situation which gives the student the best possible opportunity to develop the target level of knowledge and skills.

In addition and not to be overlooked, this course involves a responsibility to the regulatory agency--to assure that students acquire specified knowledge and skills and that these skills are acquired to a level such that data reported by the student will be accepted as reliable by the regulatory authority.

Announcing the course

This section gives examples of course announcements and identifies specific information which should be provided in any course announcement.

Summary plan for the course

This is a one-page summary of the course plan in which the reader can discover the subject matter coverage, days and approximate time allocations and the designation of the instructional specialty involved in presenting the instruction.

Sample course schedule

This covers the same information as the summary plan. The format is different, providing a day-by-day, hour-by-hour class schedule. This schedule-format has been found most practical at EPA training centers for more than 20 years. It works. It is recommended for your use.

Milestones in course planning and preparation

Each member of the training staff has individual and cooperative duties in planning and conducting the course. Much of the responsibility of each staff member is outlined later in this Guide in the section on Training Staff (Outline 6). The milestone chart shown here is an example of a plan to accomplish necessary tasks in a timely manner. It is necessary that each training institution develop its own logistics of course preparation to meet the situation at hand. It is urged that a formal milestone chart be developed.

1. Responsibilities in Self-Monitoring Training

a. Implications of NPDES

Each Permit issued under the National Pollutant Discharge Elimination System (NPDES) includes a program of required self-monitoring analyses of effluents and reporting of results at prescribed intervals.

1) The procedures to be followed in performing the self-monitoring tests and measurements are listed in Table I. (pp. 1-5 through 1-17). This Table was derived from the Federal Register: Vol. 41, No. 232, Wednesday, December 1, 1976.

2) In some cases, two or more alternative procedures are available to the analyst for compliance with monitoring requirements.

3) Provisions do exist whereby the regulatory agencies (State and EPA) can recommend and permit use of methods not listed in the FR. Procedures for orderly application of accepted methods are described in the FR issuance at the end of this section. It cannot be too strongly emphasized that the Permit-holder does not have the authority to make a unilateral decision to introduce analytical procedures not found in the FR issuances or not specifically authorized by the appropriate regulatory authorities.

b. Training Response to NPDES/FR Requirements

1) Methods taught in this and associated courses developed by EPA are limited to those most recently prescribed in issuances of the FR.

2) Usually, when alternative methods are available, the course will include only one of the alternatives. In planning the details of a specific course offering, a training representative should in every case consult with responsible representatives of the regulator agency in the area in which the course is conducted. This consultation should include determination of:

a) Which, if any, of more than one alternative analytical method is preferred (or required) by the regulatory agency for the Permit-holders under its jurisdiction?

b) What, if any, changes have occurred since the last course offerings which require adjustment in course content?

c) What advice does the regulatory agency have to offer about the planned course presentation based on problems encountered in implementation of self-monitoring procedures and in observations of performance of past graduates from previous offerings of the course?

3) The training institution which fails to apply these elementary practices, with a result of sometimes teaching inappropriate methods, stands in danger of committing a serious disservice to those it purports to serve:

a) To the students enrolled in the course; and

b) To the Permit-holding organization which is being led to believe that through this training the qualifying student will perform self-monitoring tests and measurements in accordance with methods approved by the regulatory authority.

C. Responsibilities in Accreditation of Students

1) Successful completion of this course of training will be a factor used by many regulatory agencies in the accreditation or certification of treatment plant personnel to perform self-monitoring tests and measurements.

2) The instructional staff has a responsibility to provide a learning experience through which the qualifying student will have every expectation of being able to perform the required self-monitoring procedures in a satisfactory manner on return to his normal working environment.

3) Student Evaluation and Testing

For permanent record of qualification and performance, a record of student performance should be made.

a) Tests (both written and applied) should be criterion tests; i.e., designed to demonstrate ability of the student to perform the required analyses, as contrasted with tests designed to develop a comparative rating of the individual students.

b) Written tests should be strictly applied to the procedures being taught and should be appropriate to a written answer. Thus, definitions, matters of specific information, solving of problems, and similar matters are appropriate to written tests.

c) Many students will take alarm at written tests and may not perform up to expectations due to this alarm. One means of alleviating this fear is to give open-book quizzes but to expect a high standard of performance. It is pointed out here that it is more important for the student to know where to refer for needed facts and to check these facts, than it is to demonstrate rote memory. The memory will come with practice of the test procedures. The student should learn to check the facts when in doubt, rather than risk a blunder.

d) Much of the student evaluation will be based on performance in the laboratory. It will be appropriate to keep records on such factors in student performance as:

(1) Accuracy in following directions as given:

(2) Demonstration of acceptable manipulative skills;

(3) Reporting of laboratory results falling within acceptable relationship to a class norm; and other factors as determined by the instructor.

e) Each instructor is responsible for reporting the quality of performance of each student for the procedures for which he has primary responsibility. These reports should be written, and they should be made a part of the permanent course record. This course plan provides for having at least two instructors in the laboratory during all laboratory phases of the course. At any given session, one instructor will be the designated primary instructor with others in a supporting role. To make a system like this work satisfactorily in evaluation of students and to assure consistence in student instruction, each member of the instructional team has definite, if implied, responsibilities. These include:

(1) The primary instructor is the individual who reports on acceptability or non-acceptability of student performance.

(2) The instructor-assistant(s) must instruct students in the same way as designated by the primary instructor. Introduction of individuality in manipulative procedures, order of proceeding with a test, etc., can only confuse the student.

(3) The instructor-assistant(s) should bring the problem-student to the attention of the primary instructor at the earliest possible moment. This is to provide maximum opportunity to correct problems which might result in failure of the student to qualify in a given analytical procedure.

(4) Primary instructor and instructor-assistants have, of course, a continuing responsibility of perserving the highest standards of professional and ethical relationships with each other throughout the course. Differences of opinion will arise among individuals of any instructional staff. These differences must be resolved outside the classroom and laboratory. Furthermore, these differences are not subjects for airing with students at any time.

4) The Nonqualifying Student

a) There is a job/financial implication to any student failing to qualify for any of the analytical tests and measurements included in this course. Therefore, instructors should be particularly careful to document the reasons for any nonqualification.

b) Any nonqualifying student should be entitled to be informed on the reasons why he is judged nonqualifying.

c) Ideally, an opportunity should be provided for nonqualifying students to have another chance to correct deficiencies in their performance. This could be accomplished through a number of different approaches, such as makeup work (evenings) during the course itself, through repeating the training module in which acceptable results were not achieved (at a mutually agreeable time for the student and for the instructor), or by enrollment in a future offering of the course with participation only in the module which was failed the first time around.

Table I.--List of approved test procedures

		Reference (page nos.)				
Parameter and units	Method	1974 EPA methods	14th ed. standard methods	Pt.31 1975 ASTM	USGS methods	Other approved methods
1. Acidity, as CaCO^3, milligrams per liter.	Electrometer end point (pH of 8.2) or phenolphthalein end point.	1	273(4d)	116	40	(607)
2. Alkalinity, as CaCO^3, milligrams per liter.	Electrometric titration (only to pH 4.5) manual or automated, or equivalent automated methods.	3	278	111	41	(607)
		5				
3. Ammonia (as N), milligrams per liter.	Manual distillation (at pH 9.5) followed by nesslerization, titration, electrode, Automated phenolate.		410			
		159	412	237	116	(614)
		165				
		168	616			
BACTERIA						
4. Coliform (fecal), number per 100ml.	MPN; membrane filter		922			
			937		(45)	
5. Coliform (fecal) in presence of chlorine, number per 100 ml.	------do,		922			
			928, 937			
6. Coliform (total), number per 100 ml.	------do,		916			
			928		(35)	

	Parameter and units	Method	References (page nos.)				
7.	Coliform (total), in presence of chlorine, number per 100 ml	MPN; membrane filter	---	916	---	---	---
		with enrichment.	---	933	---	---	---
8.	Fecal streptococci, number per 100 ml.	MPN; membrane filter	---	943	---	---	---
		plate count.	---	944	---	(50)	---
			---	947	---	---	---
9.	Benzidine, milligrams per liter.	Oxidation--colorimetric.	---	---	---	---	---
10.	Biochemical oxygen demand, 5 day (BOD_5), milligrams per liter.	Winkler (Azide modification) or	---	543	---	(50)	---
		electrode method.	---	---	---	---	(17)
11.	Bromide, milligrams per liter.	Titrimetric, iodine-iodate	14	---	323	58	---
12.	Chemical oxygen demand (COD), milligrams per liter.	Dichromate reflux	20	550	472	124	(610)
			---	---	---	---	(17)
13.	Chloride, milligrams per liter.	Silver nitrate;	---	303	267	---	---
		mecuric nitrate; or	29	304	265	---	(615)
		automated colorimetric-ferricyanide.	31	613	---	(46)	---
14.	Chlorinated organic compounds (except pesticides), milligrams per liter.	Gas chromatography	---	---	---	---	---
15.	Chlorine--total residual, milligrams per liter.	Iodometric titration,	---	318	---	---	---
		amperometric or	35	322	278	---	---
		starch-iodine end-point;	---	332	---	---	---
		DPD colorimetric or Titrimetric methods (these last 2 are interim methods pending laboratory testing)	---	329	---	---	---

	Parameter and units	Method	References (page nos.)				
16.	Color, platinum cobalt units or dominant wave length, hue, luminance, purity.	Colorimetric; spectrophotometric; or ADMI procedure.	36 39	64----- 66-----	 -----	82 ----- -----	----- -----
17.	Cyanide, total, milligrams per liter.	Distillation followed by silver nitrate titration or pyridine pyrazolone (or barbituric acid) colorimetric.	40	361	503	85	(22)
18.	Cyanide amenable to chlorination, milligrams per liter.	--------do--------------	49	376	505-----	-----	-----
19.	Dissolved oxygen, milligrams per liter.	Winkler (azide modification) or electrode method.	51 56	443 450-----	368 -----	126 -----	(609) -----
20.	Fluoride, milligrams per liter.	Distillation followed by ion electrode; SPADNS: or automated complexone.	----- 65 59 61	389----- 391 393 614-----	----- 307 305----- -----	----- 93----- ----- -----	----- ----- ----- -----
21.	Hardness--Total, as $CaCO_3$, milligrams per liter.	EDTA titration; automated colorimetric; or atomic absorption (sum of Ca and Mg as their respective carbonates).	68 70----- -----	202 ----- -----	161 ----- -----	94 ----- -----	(617) ----- -----
22.	Hydrogen ion (pH), pH units.	Electrometric measurement.	239	460	178	129	(606)
23.	Kjeldahl nitrogen (as N), milligrams per liter.	Digestion and Distillation followed by nesslerization, titration, or electrode; automated digestion automated phenolate.	175 165----- 182-----	437----- ----- -----	----- ----- -----	122 ----- -----	(612) ----- -----

	Parameter and units	Method	References (page nos.)		
	METALS				
24.	Aluminum--Total, milligrams per liter.	Digestion followed by atomic absorption or by colorimetric (Eriochrome Cyanine R).	92 ---	152--- 171---	(19)--- ---
25.	Aluminum--Dissolved, milligrams per liter.	0.45 micron filtration followed by referenced methods for total aluminum.	---	---	---
26.	Antimony--Total, milligrams per liter.	Digestion followed by atomic absorption.	94---	---	---
27.	Antimony--Dissolved, milligrams per liter.	0.45 micron filtration followed by referenced method for total antimony.	---	---	---
28.	Arsenic--Total, milligrams per liter.	Digestion followed by silver diethyldithiocarbamate; or atomic absorption.	--- 9 95	285--- 283--- 159	--- (31)--- (37)
29.	Arsenic--Dissolved, milligrams per liter.	0.45 micron filtration followed by referenced method for total arsenic.	---	---	---
30.	Barium--Total, milligrams per liter.	Digestion followed by atomic absorption.	97	152---	52---
31.	Barium--Dissolved, milligrams per liter.	0.45 micron filtration followed by referenced method for total barium.	---	---	---

	Parameter and units	Method	References (page nos.)
	METALS		
32.	Beryllium--Total, milligrams per liter.	Digestion followed by atomic absorption or by colorimetric (Aluminon).	99 152--------- 53------------------ -------------- 177--
33.	Beryllium--Dissolved, milligrams per liter.	0.45 micron filtration followed by referenced method for total beryllium	---
34.	Boron--Total, milligrams per liter.	Colorimetric (Curcumin)---	13 287--
35.	Boron--Dissolved, milligrams per liter.	0.45 micron filtration followed by referenced method for total boron.	---
36.	Cadmium-Total, milligrams per liter.	Digestion followed by atomic absorption or by colorimetric (Dithizone)	101 148 345 62(619) (37) --------- 182 -------------------------------------
37.	Cadmium--Dissolved, milligrams per liter.	0.45 micron filtration followed by referenced method for total cadmium.	---
38.	Calcium--Total, milligrams per liter.	Digestion followed by atomic absorption or EDTA titration.	103 148 345 66------------------ ------------- 189--
39.	Calcium--Dissolved, milligrams per liter.	0.45 micron filtration followed by referenced method for total calcium.	---
40.	Chromium VI, milligrams per liter.	Extraction and atomic absorption; colorimetric (Diphenylcarbazide).	89,105---------------------- 76------------------ ----------- 192----------------- 75

	Parameter and units	Method	Reference (page no.)				
41.	Chromium VI-Dissolved, milligrams per liter.	0.45 micron filtration followed by referenced method for chromium VI.	----------	----------	----------	----------	----------
42.	Chromium--Total milligrams per liter.	Digestion followed by atomic absorption or by colorimetric (diphenylcarbazide.	105 ----------	148 192	345 286	78 77	(619) ----------
43.	Chromium--Dissolved, milligrams per liter.	0.45 micron filtration followed by referenced method for total chromium.	----------	----------	----------	----------	----------
44	Cobalt--Total, milligrams per liter.	Digestion followed by atomic absorption.	107	148	345	80	(37)
45.	Cobalt--Dissolved, milligrams per liter.	0.45 micron filtration followed by referenced method for total cobalt.	----------	----------	----------	----------	----------
46.	Copper--Total, milligrams per liter.	Digestion followed by atomic absorption or by colorimetric (neocuproine).	108 ----------	148 196	345 293	83 ----------	(619) (37) ----------
47.	Copper--Dissolved, milligrams per liter.	0.45 micron filtration followed by referenced method for total copper.	----------	----------	----------	----------	----------
48.	Gold--Total, milligrams per liter	Digestion followed by atomic absorption.	----------	----------	----------	----------	----------
49.	Iridium--Total, milligrams per liter.	Digestion followed by atomic absorption.	----------	----------	----------	----------	----------
50.	Iron--Total, milligrams per liter.	Digestion followed by atomic absorption or by colorimetric (phenanthroline).	110 ----------	148 208	345 326	102 ----------	(619) ----------
51.	Iron--Dissolved, milligrams per liter.	0.45 micron filtration followed by referenced method for total iron.	----------	----------	----------	----------	----------

	Parameter and units	Method	Reference (page nos.)				
	METALS						
52.	Lead--Total, milligrams per liter.	Digestion followed by atomic absorption or by colorimetric (Dithizone).	112	148 215	345	105	(619)
53.	Lead--Dissolved, milligrams per liter.	0.45 micron filtration followed by referenced method for total lead.	----------				
54.	Magnesium--Total, milligrams per liter.	Digestion followed by atomic absorption; or gravimetric.	114	148 221	345	109	(619)
55.	Magnesium--Dissolved milligrams per liter.	0.45 micron filtration followed by referenced method for total magnesium.	----------				
56.	Manganese--Total milligrams per liter.	Digestion followed by atomic absorption or by colorimetric (Persulfate or periodate).	116	148 225,227	345	111	(619)
57.	Manganese--Dissolved milligrams per liter.	0.45 micron filtration followed by referenced method for total manganese.	----------				
58.	Mercury--Total, milligrams per liter.	Flameless atomic absorption.	118	156	338	(51)	----------
59.	Mercury--Dissolved, milligrams per liter.	0.45 micron filtration followed by referenced method for total mercury.	----------				
60.	Molybdenum--Total, milligrams per liter.	Digestion followed by atomic absorption.	139	----------	350	----------	
61.	Molybdenum--Dissolved, milligrams per liter.	0.45 micron filtration followed by referenced method for total molybdenum.	----------				

	Parameters and Units	Method	Reference (page nos.)			
62.	Nickel--Total, milligrams per liter.	Digestion followed by atomic absorption or by colorimetric (Heptoxime).	141 -----	148 -----	345 -----	115 ----- -----
63.	Nickel--Dissolved, milligrams per liter.	0.45 micron filtration followed by referenced method for total nickel.	-----	-----	-----	-----
64.	Osmium--Total, milligrams per liter.	Digestion followed by atomic absorption.	-----	-----	-----	-----
65.	Palladium--Total, milligrams per liter.	Digestion followed by atomic absorption.	-----	-----	-----	-----
66.	Platimum--Total, milligrams per liter.	Digestion followed by atomic absorption.	-----	-----	-----	-----
67.	Potassium--Total, milligrams per liter.	Digestion followed by atomic absorption, colorimetric (Cobaltinitrite), or by flame photometric.	143 ----- -----	----- 235 234	(620) ----- 403	134 ----- -----
68.	Potassium--Dissolved, milligrams per liter.	0.45 micron filtration followed by referenced method for total potassium.	-----	-----	-----	-----
69.	Rhodium--Total, milligrams per liter.	Digestion followed by atomic absorption.	-----	-----	-----	-----
70.	Ruthenium--Total, milligrams per liter.	Digestion followed by atomic absorption.	-----	-----	-----	-----
71.	Selenium--Total, milligrams per liter.	Digestion followed by atomic absorption.	145	159	-----	-----

Parameter and units	Method	Reference (page nos.)					
METALS							
72. Selenium--Dissolved, milligrams per lieter.	0.45 micron filtration followed by referenced method for total selenium.	---	---	---	---	---	---
73. Silica--Dissolved, milligrams per liter.	0.45 micron filtration followed by colorimetric (Molybdosilicate).	274	487	398	139	---	---
74. Silver--Total, milligrams per liter.	Digestion followed by atomic absorption or by colorimetric (Dithizone).	146 ---	148 243	--- ---	142 ---	(619) ---	(37) ---
75. Silver--Dissolved, milligrams per liter.	0.45 micron filtration followed by referenced method for total silver.	---	---	---	---	---	---
76. Sodium--Total, milligrams per liter.	Digestion followed by atomic absorption or by flame photometric.	147 ---	--- 250	--- 403	148 ---	 ---	(621) ---
77. Sodium--Dissolved, milligrams per liter.	0.45 micron filtration followed by referenced method for total sodium.	---	---	---	---	---	---
78. Thallium--Total, milligrams per liter.	Digestion followed by atomic absorption.	149	---	---	---	---	---
79. Thallium--Dissolved, milligrams per liter.	0.45 micron filtration followed by referenced method for total thallium.	---	---	---	---	---	---
80. Tin--Total, milligrams per liter.	Digestion followed by atomic absorption.	150	---	---	(65)	---	---
81. Tin--Dissolved, milligrams per liter.	0.45 micron filtration followed by referenced method for total tin.	---	---	---	---	---	---

	Parameter and units	Method	Reference (page nos.)					
	METALS							
82.	Titanium--total, milligrams per liter.	Digestion followed by atomic absorption.	151	------	------	------	------	------
83.	Titanium--Dissolved milligrams per liter.	0.45 micron filtration followed by referenced method for total titanium.	------	------	------	------	------	------
84.	Vanadium--Total, milligrams per liter.	Digestion followed by atomic absorption or by colorimetric (Gallic acid).	153 -------	152 260	------ 441	------ (67)	------ ------	------ ------
85.	Vanadium--Dissolved, milligrams per liter.	0.45 micron filtration followed by referenced method for total vanadium.	------	------	------	------	------	------
86.	Zinc--Total, milligrams per liter.	Digestion followed by atomic absorption or by colorimetric (Dithizone).	155 ----------	148 265	345 ------	159 ------	(619) ------	(37) ------
87.	Zinc--Dissolved, milligrams per liter.	0.45 micron filtration followed by referenced method for total zinc.	------	------	------	------	------	------
88.	Nitrate (as N), milligrams per liter.	Cadmium reduction; brucine sulfate; automated cadmium or hydrazine reduction.	201 197 207	423 427 620	------ 358 ------	------ 119 ------	------ (614) ------	------ (28) ------
89.	Nitrite (as N), milligrams per liter	Manual or automated colorimetric (Diazotization).	215	434	----------	121	------	------

Parameter and units	Method	Reference (page nos.)				
90. Oil and grease, milligrams per liter.	Liquid-liquid extraction with trichloro-trifluoroethane-gravimetric.	229	515	-------	-------	-------
91. Organic carbon; total (TOC) milligrams per liter.	Combustion--Infrared method.	236	532	467	(4)	-------
92. Organic nitrogen (as N), milligrams per liter.	Kjeldahl nitrogen minus ammonic nitrogen.	175,159	437	-------	122	(612,614)
93. Orthophosphate (as P), milligrams per liter.	Manual or automated ascorbic acid reduction.	249 256	481 624	384 -------	131 -------	(621) -------
94. Pentachlorophenol, milligrams per liter.	Gas chromatography	-------	-------	-------	-------	-------
95. Pesticides, milligrams per liter.	-------do-------	-------	555	529	(24)	-------
96. Phenols, milligrams per liter.	Distillation followed by Colorimetric (4AAP).	241	574	545	-------	-------
97. Phosphorus (elemental), milligrams per liter.	Gas chromatography	-------	-------	-------	-------	-------
98. Phosphorus; total (as P), milligrams per liter.	Persulfate digestion followed by manual or automated ascorbic acid reduction.	249 256	476,481 624	384 -------	133 -------	(621) -------
RADIOLOGICAL						
99. Alpha--Total, pCi per liter.	Proportional or scintillation counter.	-------	648	591	(75+78)	-------

Parameter and units	Method	Reference (page nos.)				
100. Alpha--Counting error, pCi per liter.	do		648	594	(79)	
101. Beta--Total, pCi per liter.	Proportional counter		648	601	(75+78)	
102. Beta--Counting error, pCi per liter.	do		648	606	(79)	
103. (a) Radium--Total, pCi per liter.	do		661	661		
(b) Ra, pCi per liter.	Scintillation counter		667		(81)	
RESIDUE						
104. Total, milligrams per liter.	Gravimetric, 103 to 105°C.	270	91			
105. Total, dissolved (filterable) milligrams per liter.	Glass fiber filtration, 180°C.	266	92			
106. Total suspended (nonfilterable), milligrams per liter.	Glass fiber filtration, 103 to 105°C.	268	94			
107. Setteable, milliters per liter or milligrams per liter	Volumetric or gravimetric.		95			
108. Total volatile, milligrams per liter.	Gravimetric, 550°C	272	95			
109. Specific conductance, micromhos per centimeter at 25°C.	Wheatstone bridge conductimetry.	275	71	120	148	(606)
110. Sulfate (as SO_4), milliper liter.	Gravimetric; turbidimetric		493	424		(624)
	or automated colori-	277	496	425		(623)
	(barium chloranilate).	279				

Parameter and units	Method	Reference (page nos.)				
111. Sulfide (as S), milligrams per liter.	Titrimetric--Iodine for levels greater than 1 mg per liter, Methylene Blue photometric.	284 -----	505 503	--------------- ---------------	154 ---------------	------------- -------------
112. Sulfite (as SO_3), milligrams per liter.	Titrimetric, iodine-iodate.	285	508	435	-------------	-------------
113. Surfactants, milligrams per liter.	Colorimetric (Methylene blue).	157	600	494	(11)	-------------
114. Temperature, degrees C.	Calibrated glass or electrometric thermometer.	286	125	--------	(31)	-------------
115. Turbidity, NTU.	Nephelometric.	295	132	223	156	-------------

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Taken from: Federal Register, Vol. 41, No. 232--Wednesday, December 1, 1976.

2. Announcing the Course

a. Course Availability

Course availability is most likely to be established through one of two mechanisms:

1) Management or regulatory authority determines that training is required, makes arrangements for course presentation and instructs designated personnel to appear at a specified time and place for training; or,

2) The course may be planned by a training organization which schedules and publicly announces the course either as a special offering or as an element of an overall curriculum of training.

b. Responsibility for Course Announcement

All training organizations should establish and maintain mailing lists of officials, or organizations and interested individuals to whom training announcements should be addressed.

Course announcements should be released by the training organization and/or the sponsoring agency (if applicable).

When a special course offering is planned at the request of management or regulatory authority with identified class participants, it usually is best for the requesting authority to make the announcement.

c. Types of Course Announcements

1) Training bulletins, or catalogues are widely used by established training organizations and should be used for announcement of this course when offered as part of an on-going curriculum of courses.

2) Special fliers or brochures should be developed for public announcement through established mailing lists. These releases may be used for regular offerings of an on-going curriculum of courses; but they are particularly applicable when a special offering of the course is planned.

3) The course may be announced in a journal, newsletter or other periodical widely read by the personnel for whom the training is intended.

4) The course may be announced by personal letter or other direct communication with a student assigned to take the training.

d. Timing of Course Announcements

Training catalogues or bulletins usually are for a period of one year or more. Accordingly, the prospective student should have from three months to one year of advance notice of the training.

When the course is a special offering announced through a flier or other special mechanism, at least 90 days should be provided between the release of the announcement and the start of the course. There are at least two reasons for this:

1) Permits course applicants to secure necessary approvals for attendance and to make personal scheduling arrangements; and,

2) Provides course presentation staff with lead time for course preparations, acquiring special instructional materials, preparation of laboratory supplies and equipment, and related tasks.

e. Information Provided in Course Announcements

The following list should be helpful as a checklist to those preparing a course announcement. Samples of an announcement for this course as it might appear in a catalogue of courses, and as it might appear in a special flier are shown in the section of this Guide titled SECRETARIAL SUPPORT.

In the event that the course is announced in a periodical, the editor may apply constraints on style and format which make it impossible to provide all the pertinent information on the course. In such cases the announcement must provide the name and address of an office from which further information can be obtained. The information to be provided should be as complete as that given in a course catalogue or flier and naturally should include any additional special information specifically requested.

The following will be helpful as a checklist to those preparing an original course announcement:

1) Course title, dates and location

2) Name of organization conducting the course (and name of co-sponsor, if applicable)

3) Description of intended student body, reason why this training is needed and summary of Course content.

4) Prerequisites for attendance (special skills or training which the applicant must have for admission)

5) Description of the training environment to be used (classroom, laboratory, field, in-plant, etc.)

6) Identification of knowledge and skills the participant will have on satisfactory completion of training

7) Tuition (if applicable)

8) How and where to apply for admission to this course

3. Summary Plan for the Course

A convenient format to use in the early stages of devising a course plan is a day-to-day assignment of time blocks based on estimates by authors of the training time required for each parameter. (An example is on the next page.) Using available time as a first criterion will allow a variety of possible sequences. Then other considerations should be applied. Some examples are:

a. If some equipment must be used in more than one test, schedule another topic between the two tests to allow time for the required clean-up.

b. Schedule the topics so each instructor alternates between prime and assistant responsbilities to allow time for preparations which must be done right before training sessions.

c. If one procedure requires skills taught in another procedure, order the presentations accordingly.

d. If most students need only 80% of the procedures taught, schedule the remaining 20% of the procedures as a group so students can conveniently schedule their attendance for training pertinent to their needs.

Example - Summary Plan for the Course:

ESTIMATED AGENDA FOR COURSE 1

Monday		Tuesday		Wednesday		Thursday		Friday	
Activity	Time Hours	Activity	Time Hours	Activity	Time Hours	Activity	Time Hours	Activity	
Registration	1/2	Chemistry Laboratory Formulas	1 1/2	Chemical Laboratory Use of Laboratory Balances	3 1/2	Chemical Laboratory Volumetric Analysis	3 1/2	Microbiology (cont'd.	2
Mathematics Pretest	1/2								
Permit Requirements	1 1/4	Chemical Laboratory Care & Use of Equipment	2					Chemical Laboratory	1 1/2
Mathematics Review	1								
Lunch	1	Lunch	1	Lunch	1	Lunch	1	Lunch	1
Chemistry Laboratory Safety	1	Chemical Laboratory Matter & Solutions	3 1/2	Chemical Laboratory Volumetric Analysis	3 1/2	Microbiology	3 1/2	Ordering Equipment	1 1/2
Chemistry Laboratory Bench Sheets Labeling & Formulas	2 1/2							Evaluation & Closing	1/2
TOTAL	7 3/4	TOTAL	8	TOTAL	8	TOTAL	8	TOTAL	6 1/2

Sample Course Schedule

SELF-MONITORING PROCEDURES-COURSE I
BASIC LABORATORY SKILLS

Charles County Community College

July 12 - 16, 1976

Day & Time	SUBJECT	Instructor
Monday, July 12		
8:30 - 9:00	Registration	Course Coordinator
9:00 - 9:30	Mathematics Pre-test	Course Coordinator
9:30 - 9:45	Break	
9:45 - 11:00	Permit Requirements	Course Coordinator
11:00 - 12:00	Mathematics Review	Course Coordinator
12:00 - 1:00	Lunch	
1:00 - 2:00	Chemistry Laboratory Safety	Chemist
2:00 - 4:30	Chemistry Laboratory Bench Sheets Labeling & Formulas	Chemist
Tuesday, July 13		
8:30 - 10:00	Chemistry Laboratory Formulas	Chemist
10:00 - 12:00	Chemistry laboratory Care & Use of Equipment	Chemist
12:00 - 1:00	Lunch	
1:00 - 4:30	Chemical Laboratory Matter & Solutions	Chemist
Wednesday, July 14		
8:30 - 12:00	Chemical Laboratory Use of Laboratory Balances	Chemist
12:00 - 1:00	Lunch	

DAY & TIME	SUBJECT	INSTRUCTOR*
Wednesday, July 14 Cont'd.		
1:00 - 4:30	Chemical Laboratory Volumetric Analysis	Chemist
Thursday, July 15		
8:30 - 12:00	Chemical Laboratory Volumetric Analysis	Chemist
12:00 - 1:00	Lunch	
1:00 - 4:30	Microbiology	Microbiologist
Friday, July 16		
8:30 - 10:30	Microbiology Cont'd.	Microbiologist
10:30 - 12:00	Chemical Laboratory	Chemist
12:00 - 1:00	Lunch	
1:00 - 2:30	Ordering Equipment	Staff
2:30 - 3:00	Evaluation & Closing	Staff

*NOTE: For actual course presentation, insert the name of the instructor instead of the technical specialty, as shown.

5. Milestones in Course Planning and Preparation

The following pages list major areas of course responsibilities in a chronological order to facilitate orderly and timely accomplishment. The table also serves as an example for assignment of these responsibilities to various staff members. The Staff Guide (Chapter) number of the related outline is given for each listing so that the user can quickly find the details about his/her assignments.

The table headings are job titles associated with the listed tasks. A maximum staff is cited, including a laboratory assistant. It is recognized, however, that staff is often limited and one individual may serve in several of the defined roles. Having this summary according to an ideal situation should facilitate an equitable division of the required tasks among fewer persons.

The requirements of area NPDES permits and/or the type of equipment readily available will help the course planners make choices among these possibilities.

	Training Supervisor	Course Coordinator	Course Secretary	Chemist #1	Chemist #2	Microbiologist	Lab Assistant	Staff Guide Outline No.
5 TO 6 MONTHS BEFORE COURSE								
Determination of the need and decision to have course.	x							1,2
Designation of Course Director and Course Secretary.	x							
Review responsibilities.		x						PREFACE, 1 thru 12
Review responsibilities.			x					PREFACE, 1, 6, 10, 11, 12
Commit classroom and laboratory facilities.	x	x						7
Develop and release Course Announcement including location, date, general statement of course content and training objectives.		x	x					2
Prepare all forms and information sheets related to student registration procedures.		x	x					10,11,12
Decide on staff members.	x	x						6
4 TO 5 MONTHS BEFORE COURSE								
Receive, review, act upon Course Applications, continuing until course begins.		x	x					10,11, 12
Maintain records on deposition of each application, continuing through course.			x					10,11,12
Inventory Staff Guides, Order needs.		x	x					9

	Training Supervisor	Course Coordinator	Course Secretary	Chemist #1	Chemist #2	Microbiologist	Lab Assistant	Staff Guide Outline No.
3 MONTHS BEFORE COURSE								
Commit all staff members who will participate in Course.	x	x		x	x	x	x	6
Develop Milestone Checklist for Course.		x	x					5
Distribute copies to staff of Milestones, Staff Guide, Student Text and any other pertinent training resources.	x	x	x					5,9
Review responsibilities.				x	x	x	x	PREFACE, 1,6,10, 12,13
Assign topics to Primary (P) and Assistant (A) Instructors:	x	x						
Permit Requirements		P		A				N/A
Mathematics Modules		P						15
Chemical Laboratory				P	A			16
Microbiology				A		P		17
Inventory		P						18
Decide which procedures to teach if EMP has choices. Record on related IPW.	x	x		x	x	x	x	8 and 13 thru 22
Mark which procedures are to be taught on the summary of laboratory equipment and supply needs for course.		x		x	x	x	x	8
Develop summary plan for course.		x	x	x	x	x	x	3
Inventory chemicals and laboratory equipment/ supplies. List and commit lending sources. Order rest of needs.	x	x	x	x	x	x	x	8

(Continued)

	Training Supervisor	Course Coordinator	Course Secretary	Chemist #1	Chemist #2	Microbiologist	Lab Assistant	Staff Guide Outline No.
Inventory classroom equipment/supplies. List and commit lending sources. Order rest of needs.		x	x					7
Inventory student reference texts. Order needs.		x	x					9
2 MONTHS BEFORE COURSE								
Finalize Course Schedule (Agenda)		x	x	x	x	x	x	4
Request laboratory/classroom needs from lending sources.		x	x	x	x	x	x	7, 8
Request training aids from lending sources.		x	x	x	x	x		9
6 WEEKS BEFORE COURSE								
Check out operation of all items listed as "A" Capital Equipment" plus COD reflux apparatus.				x	x	x	x	8
Primary and Assistant Instructors go through EMP laboratory procedures in student reference texts, using IPWs to standardize instructions for students.				x	x	x		13 thru 22
1 MONTH BEFORE COURSE								
Summary (to date) to staff of registered students, continuing to course beginning.		x	x					
Check on progress of staff preparations for instruction continuing through course.		x		x	x	x		6

(Continued)

	Training Supervisor	Course Coordinator	Course Secretary	Chemist #1	Chemist #2	Microbiologist	Lab Assistant	Staff Guide Outline No.
Prepare all administrative forms and materials needed for course preparation.		x	x					10, 11, 12
Plan and rehearse classroom presentations using all required training aids. Finalize.				x	x	x		13 thru 22
Obtain any duplicated instructional materials (data sheets, etc.)			x	x	x	x	x	12 and 13 thru 22
Review summary of laboratory equipment and supply needs for expected number of students doing the selected procedures.		x					x	8
Clean all glassware required by students [Special for Phosphorus, COD, Ammonia (distillation apparatus)]							x	8, 16, 17, 18, 19
Reserve all specially-cleaned glassware.							x	8, 16, 17, 18, 19
Assemble other student equipment and supplies.							x	8
2 WEEKS BEFORE COURSE								
Arrange for security of classroom and laboratory.		x	x					7
Make reagents required by students EXCEPT those with specified, limited stability.				x	x	x	x	8 and 13 thru 22
Make final arrangements to obtain required effluent samples.				x	x	x	x	8 and 13 thru 22

(Continued)

	Training Supervisor	Course Coordinator	Course Secretary	Chemist #1	Chemist #2	Microbiologist	Lab Assistant	Staff Guide Outline No.
Determine range of concentration of desired constituent in effluent sample from source of course samples.				x	x	x		8 and 13 thru 22
Arrange for disposal of special test wastes (COD, alkaline wastes, Cd)				x	x		x	17, 18, 19, 20
Give Laboratory Assistant final list of equipment and supplies to be at each laboratory position. Discuss arrangement of shared equipment.				x	x	x		13 thru 22
1 WEEK BEFORE COURSE								
Inform building food service of number of expected students and course lunch times (as appropriate).			x					
3 DAYS BEFORE COURSE								
Finalize seating arrangement for classroom.		x						7
Assemble course materials in classroom (student texts administrative materials, etc.). Distribute as appropriate.		x	x					9, 10, 11, 12
Ready classroom instructional aids (boards, erasers, etc.)		x	x				x	7
Check out all classroom equipment (electrical systems, PA, projection equipment) and obtain back-up accessories (bulbs, etc.).		x						7

	Training Supervisor	Course Coordinator	Course Secretary	Chemist #1	Chemist #2	Microbiologist	Lab Assistant	Staff Guide Outline No.
COURSE OPENING								
Conduct opening exercises. Participate in course opening.	x	x	x	x	x	x	x	6
Complete any required student records, including roster.		x	x					10, 11, 12
Prepare course certificates and give to Day's Instructor.								
EVERY DAY OF COURSE								
Maintain general supervision of course.		x						6
Prepare unstable reagents and/or samples on day of test.				x	x	x	x	8,16,18,19,20,22
Obtain effluent samples for each test on day of test.				x	x	x	x	8,16,17,18,19,21
When assistant instructor, make any student evaluation records requested by the instructor.				x	x	x		1,6,10, 13 thru 22
When primary instructor, compile evaluation record for each student.				x	x	x		1,6,10, 13 thru 22
When primary instructor, sign certificate of each student who satisfactorily performs test.				x	x	x		1, 12, 13 thru 22
After signing certificates, given them to next primary instructor.				x	x	x		

(Continued)

	Training Supervisor	Course Coordinator	Course Secretary	Chemist #1	Chemist #2	Microbiologist	Lab Assistant	Staff Guide Outline No.
When primary instructor, make arrangements to work with each non-qualifying student.				x	x	x		1, 13 thru 22
Oversee disposal of special test wastes.				x	x		x	17, 18, 19, 20
SECOND-LAST DAY OF COURSE								
Distribute course critique sheet to students.		x						
LAST DAY OF COURSE								
Assemble certificates, check for completeness and sign.		x						12
Collect students' critique sheets.		x						
Conduct closing exercises and distribute certificates.		x						6
Participate in course closing.	x		x	x	x	x	x	6
Clean up classroom and laboratory.		x	x	x	x	x	x	6
WITHIN A WEEK OF COURSE PRESENTATION								
Return or replace any borrowed classeoom equipment/supplies.		x	x					7
Return or replace any borrowed laboratory equipment/supplies.				x	x	x	x	8
Return or replace any borrowed training aids.		x	x	x	x	x		9

(Continued)

	Training Supervisor	Course Coordinator	Course Secretary	Chemist #1	Chemist #2	Microbiologist	Lab Assistant	Staff Guide Outline No.
Order repairs or replacements of own equipment used in course.		x	x	x	x	x		7, 8, 9
File evaluation records on all student in predetermined area.			x	x	x	x		10
Participate in staff session on evaluation of course and recommendations for future offerings.	x	x	x	x	x	x	x	6, 10
Prepare course summary/ evaluation report.		x						6
Complete and file entire course records in mutually determined area.		x	x					10, 11, 12

B. Training Resources

This section considers four topics: Training Staff, Training Facilities, Laboratory Equipment and Supply Requirements, and Instructional Resources.

Staffing plans, facilities equipment and supplies described in this Guide are based on a class of 15 students. For at least the first several (3 or 4) course offerings, it is urged that this maximum number of students per class be strictly followed.

A staff experienced in presentation of this course may be able to increase class size to perhaps 18 students. In no instance should this laboratory-oriented course exceed 18 students with an instructional staff of the size described here. Large numbers of students per instructor simply cannot be provided with the individual attention and instruction required for effective training and assurance that they have indeed learned to perform the analyses which are the subject of this course.

If the number of workers requiring this course is quite large, the best course of action is to meet the training need through providing a greater number of course offerings.

The required instructional resources, shown in outline 9, are compiled from the individual instructional package worksheets shown in Part B. Training administrators should coordinate requrests for instructional resources to be acquired through loan or through purchase from other sources. This outline provides a basis for such coordination.

1. Training Staff

Each member of the training staff for this as for any short course is a member of a team. This team can function effectively only through each member's understanding of the training goals to be met and the plans for meeting these goals. If each member performs his/her own duties and provides mutually supportive activity with other team members, the effective conduct of the course as a whole can be achieved.

a. Qualifications of Instructional Staff

1) Each should have a thorough knowledge of the subject matter for which he/she has responsibility, including a high order of technical skill in any procedures to be carried out.

2) Each should be able to perform effectively as an instructor, both in the classroom and in the laboratory. This includes ability to make rapid adjustments in the style and technical level of instruction in order to work with students having a varied range of entry-level knowledge, skills, and prior education.

3) Each should be willing to accept a certain rigidity in the choice of analytical procedures to be taught, in accordance with policies

and formal directives of the applicable regulatory authority (-ies). The basis for and recommended procedures to be followed in introducing variations in methods to be taught in tests and measurements of municipal effluents are discussed elsewhere in this Guide.

b. Estimated Time Allocations for Training Staff

Each member of the training staff has specific duties before, during, and after the scheduled course dates. For planning purposes, it is assumed that pre-course activity will begin three months or more, as required, before classroom instruction begins. During this period, the estimated time allocations will permit the phasing-in of work activity for this course with other duties of all personnel. During the course, all instructional staff and laboratory assistant (if used) are fully occupied and should not be given any other duty assignments. Post-course activities should be completed within one or two weeks after the last day of instruction. In the post-course period all staff may begin to phase in other duties pending final completion of all details associated with this training effort.

Staff Identification	Working Days (estimate)		
	Before	During	After
Course Administration			
Course Coordinator (ordinarily, this is one of the instructional staff, who is assigned double-duty as coordinator-instructor)	12	1	2
Course Secretary	10	2	2
Instructional Staff			
Chemist #1	8	5	2
Chemist #2	8	5	2
Microbiologist	4	4	2
Laboratory Support			
Laboratory Assistant Optional)	10	5	5

c. Duties and Responsibilities of Training Staff

1) Course Coordinator

This individual may be known variously as Course Director, Course Leader, or some other term suitable to the situation. In most cases the Course Coordinator will function in a dual capacity as one of the instructional staff for the course. In principle, any one of the Instructors could function as Course Coordinator. In the absence of other factors, it may be best to have the individual who bears the lightest teaching load to act as Course Coordinator.

a) Before the course, the Coordinator receives assignment from management to lead the course, after which he/she:

(1) Obtains commitment of the other members of the training team for the course, including secretary, Instructors, and (if used) Laboratory Assistant;

(2) Determines the composition and geographic origin of the student body to be trained;

(3) Develops a working schedule and specific staff assignments for all significant milestone stafes of course preparation and implementation;

(4) Meets with course staff, distributes instructional guides and related training materials, and reviews the preparation plans and day-to-day working schedule; assigns specific topics and time allocation for which each Instructor has prime instructional responsibility and for which each Instructor serves as assistant to prime Instructor;

(5) Identifies which, if any available options in procedures should be taught for compliance with directives of the governing regulatory authority (-ies);

(6) Prepared announcement of the course and distributes it as appropriate to the potential student body;

(7) Reviews classroom and laboratory facilities, making arrangements for any required repairs or adaptations;

(8) In consultation with Instructors, reviews availability and condition of all equipment, supplies, and other training resources required for the course; makes timely arrangements for repair and maintenance, reorder, or borrowing of needed items;

(9) Arranges for supplies of student reference texts and associated training materials;

(10) Works with Secretary in registration of students and in all pre-course communications on schedules, local housing and transportation, and other pertinent matters;

(11) If the course is to be conducted in a "field" location, coordinates timely arrangements for staff travel, transportation of equipment and supplies, arrangement for training facilities, local housing and transporation, determination of availability and location of dining facilities, and any other preparations required for course conduct away from normal base location;

(12) Initiates periodic and timely checks with other training team members to assure that their pre-course preparations are on schedule and that preparation of required resources is moving ahead according to plan. Takes action as necessary to identify problems and to expedite solutions as the need arises;

(13) Represents the training team in all formal communications with management, host organizations, students, and with commercial or private sources of equipment and supplies.

b) During the course, the Course Coordinator:

(1) Takes charge of course opening exercises, including student registration, welcome and staff introductions. Presents and discusses course objectives;

(2) Maintains general supervision of course, assuring that all activities are kept on schedule; maintains liaison between staff members and other interfacing organizations/individuals as necessary;

(3) Maintains consolidated summary record of student performance based on information provided by other Instructors; consults with staff to determine which students should/should not be recorded as having satisfactorily met training objectives;

(4) Provides Course Secretary with timely information necessary for preparation of course certificates; signs course certificates as representative of the course training staff;

(5) Presides over course closing activities, including award of certificates.

c) After the course, the Course Coordinator:

(1) Reviews and evaluates with the instructional staff all matters considered pertinent to the effective implementation of the course as planned, developing proposals and plans for adjustments as necessary for future offerings of the course;

(2) Orders repair, renovation, and replacement of any equipment or supplies that require such attention;

(3) Coordinates return of any borrowed resources used in the course;

(4) If course was conducted in the field, coordinates repacking and return shipment of all equipment and supplies;

(5) Drafts course summary/evaluation report;

(6) Prepares and forwards any reports required by other supervising, coordinating, or financing authority.

2) Course Secretary

The Course Secretary works under the direct supervision of the Course Coordinator and prepares or arranges preparation of all formal communications, procurement documents, training materials, and records required for course preparation and implementation. The Course Secretary also provides office support work for the course instructional staff in all matters pertaining to course preparation and implementation.

a) Before the course the Course Secretary:

(1) Works with the Course Coordinator in identification and preparation of copies of all pertinent course materials for use in planning conferences between Course Coordinator and the instructional staff, including Instructors' copies of working schedules for course preparation, course agenda from preliminary to final draft, staff assignments, Instructors' instructional package worksheets, all student instructional materials and associated data sheets, student evaluation sheets, quizzes, and any other typed or printed material projected for course use;

(2) After Course Coordinator's conference with instructional staff and resolution of decision-making issues, arranges for printing (or reproduction) and assembly of all materials indicated under (1) above in a quantity adequate for projected course requirements;

(3) Arranges for printing or reproduction and distribution of the projected course announcement as directed by Course Coordinator;

(4) Serves as Registrar, maintaining roster and records of students submitting application and accepted for admission to the course; prepares routine response to students, announcing acceptance with information as appropriate on course dates and schedule, local

"geography" including key addresses, hotel/motel/dining information, local transportation information, and any other information which will simplify personal planning of registered students;

(5) Prepares or arranges for all individual student supplies, including registration cards, course manuals, note paper, pencils, name tags (1 for wearing and 1 for use at classroom seating position), course certificates, etc.;

(6) Prepares orders or procurement requests for equipment and supplies needed for the course based on specifications provided by the instructional staff;

(7) If the course is a "field" presentation, makes arrangements for shipment of equipment and supplies to and from course site, staff travel schedules and order of tickets, hotel reservations, and associated functions;

(8) Prepares the classroom for use in the course, including distribution of individual student materials to seating positions, arrangements for classroom organization of audiovisual projection or playback equipment, chalkboards and associated supplies, and other classroom needs. (Ordinarily the Course Secretary does not travel to a "field" presentation; this function will have to be provided through special arrangements with the host organization at the course site.)

b) During the course, the Course Secretary functions as an "unofficial staff hostess," and:

(1) Attends course opening exercises, assisting students in completion of registration cards and associated records;

(2) Prepares course summary registration information; prepares class roster on first day of course and distributes copies to students and instructors, keeping copies for future records;

(3) Provides clerical/secretarial support to Course Coordinator and instructional staff as required;

(4) Receives incoming mail and messages for staff and students, expediting communications to extent practical and feasible;

(5) Prepares course certificates as specified by Course Coordinator on last day of course;

(6) Inspects classroom daily, making arrangements as necessary for coordination of deficiencies in janitorial services; personally corrects minor deficiencies to extent feasible;

(7) Attends and participates in course closing exercises.

c) After the course, the Course Secretary:

(1) Prepares typed copy of all reports drafted by the Course Coordinator and forwards reports as indicated;

(2) Places purchase orders or procurement requests for repair, renovation, or replacement of equipment and supplies as directed by Course Coordinator;

(3) Removes all course supplies from the classroom, returns borrowed resources, leaves classroom in condition suitable for use by following class. (This does not imply janitorial services!);

(4) If course is conducted on a repetitive basis, inventories all consumable classroom supplies including data sheets, worksheets, quizzes, course schedules, and the like, and reorders or provides for reproduction of any items coming into short supply.

3) Instructors-Chemists

a) Before the course each Instructor receives course duty assignment from management and:

(1) Meets with Course Coordinator for discussions of course plans, objectives, and development of day-to-day course preparation schedule;

(2) In conference with Course Coordinator determines which, of any, options in tests and measurements will be taught; determines lesson guides to be followed and student reference materials to be used; and resolves any other problems on instructional materials, their content, and related matters which should be determined beforehand;

(3) Reviews requirements for equipment, supplies, audiovisual training aids, and other training resources to be used in individual instructional assignments. Performs equipment upkeep and maintenance procedures, prepares supplies and reagents required to be available for student use. Provides Course Coordinator with timely, detailed information on specifications for all equipment, supplies and other training resources which must be purchases, rented, or borrowed for the course;

(4) If the course is to be conducted in a "field" location, packs equipment and supplies for shipment so that they will arrive at destination in good condition; identifies to the Course Coordinator the equipment and supplies which should not or cannot be shipped but which should be provided at the course site, nevertheless;

(5) Rehearses all classroom and laboratory instructional presentations to the extent necessary to assure effective performance within the scheduled time allocation;

(6) Reviews and practices all tests for which he/she has responsibility as primary Instructor to assure personal proficiency and adequacy of pre-course plans and preparations. Supervises pre-course practice of those who will serve as assistant Instructors for the tests;

(7) Prepares to serve as assistant Instructor for specified tests and measurements, developing personal proficiency through pre-course practice under supervision of the applicable primary Instructor, and prepares to teach the tests and measurements in accordance with techniques specified by the primary Instructor;

(8) Reports periodically as requested to the Course Coordinator on status of course preparations and cooperates in working out timely procedures for their accomplishment.

b) During the course, each Instructor:

(1) Attends and participates in course opening exercises;

(2) Serves as primary Instructor for the tests and measurements assigned to him/her. In this capacity he/she is responsible for all classroom instruction on the designated subjects, leadership of all laboratory instruction, collection of (or arrangements for) samples for laboratory examination by class, student performance evaluation and associated records for submission to Course Coordinator, and student counseling on pertinent matters related to area of personal responsibility;

(3) Assists primary Instructor in laboratory instruction phases of the tests and measurements as assigned, including preparation and organization;

(4) Attends and participates in all classroom start-of-day evaluation sessions on previous day's student performance;

(5) Attends and participates in course closing exercises.

c) After the course, each Instructor:

(1) Reviews the course implementation experience with the Course Coordinator, mutually developing proposals and plans for future offerings of the course;

(2) Evaluates condition of all equipment and supplies, Initiating action to repair, renovate, or replace any items found deficient or in short supply;

(3) Takes necessary action to put laboratory into state of neatness and order for occupancy of the next course. (This does not imply janitorial service!);

(4) If course were conducted in the field, repacks all equipment and supplies for return to home institution, after having cleaned, at least superficially, all dirty or contaminated glassware;

(5) On return of shipment to home institution, unpacks all equipment and supplies, returning it to designated custodial site, including return of borrowed equipment and other returnable resources.

4) Laboratory Assistant

The Laboratory Assistant is designated as "optional" in the staffing plan, but services of a Laboratory Assistant are strongly recommended. This is particularly urged in a fixed training installation where this and other courses are being conducted on a continuing or repetitive basis. The Laboratory Assistant works particularly in support of the instructional staff. The Assistant will be given routine tasks which will free the instructional staff for more specialized or complicated tasks associated with the planning, preparation, and implementation of the training.

a) Before the course, the Laboratory Assistant:

(1) Works closely with the instructional staff members, performing standardized tasks as specified in the course preparation plan;

(2) Organizes laboratory supplies and equipment for each procedure in such a way as to permit distribution to the students or to their working sites with maximum efficiency during the course presentation;

(3) Assists Course Secretary wherever feasible in assembly and organization of student instructional materials, classroom preparation, and related tasks.

b) During the course, the Laboratory Assistant:

(1) Performs all possible tasks to assist primary Instructors in setting up student work positions, collecting and returning used glassware, supplies and equipment, etc., to central repository;

(2) Cleans and maintains all glassware and supplies excepting those stipulated for student performance;

(3) Promptly notifies primary Instructor of any noted discrepancies or deficiencies in supplies, equipment, or planning which would lead to problems in implementing the course;

(4) For those courses conducted in the field, packs equipment in shipping cases as soon as it is no longer needed.

c) After the course, the Laboratory Assistant:

(1) Assists Instructors in all equipment and supply inspection, renovation, and return to proper location;

(2) Puts laboratory in state of neatness and order prior to its being used for next class;

(3) Prepares any stable supplies required for next offering of the course, within limits of technical capability.

2. Training Facilities

This course requires both a classroom and a laboratory for class use. Effective presentation of the course requires staff attention to many details related to these facilities. Problems more often occur in field courses (i.e., away from "home base"). In any location it is unusual that all desired features of a training facility will be met, but with timely attention most problems can be solved or at least partially resolved.

a. General Considerations

1) Spatial Relationships

Classroom and laboratory should be separate but close together. Much of the instruction requires frequent shifts between classroom and laboratory. Therefore, the classroom and laboratory must not be in separate buildings and should not be far apart within any structure.

2) Associated Comforts

a) The classroom and the laboratory should have a comfortable temperature, be free of obvious drafts, be well-ventilated and well-lighted. It is of course possible to develop specifications for acceptable temperature ranges, light intensity ranges, humidity, etc., but there is no substitute for exercise of good judgment.

b) Suitable restroom and drinking fountain facilities should be convenient to the classroom and laboratory.

c) Smoking:

(1) NO SMOKING IN THE LABORATORY. There should be no compromise on this.

(2) Some schools permit smoking in the classrooms. If this is the practice, it is advisable to locate ashtrays so that smokers sit in an area where their smoking will not disturb others.

3) Lunchroom Facilities

Most schedules for this course will allow a one-hour lunch break. It is advisable that the course staff identify and make known to the class the names and locations of convenient dining facilities where service, variety, quality, and price are satisfactory.

4) Comments to Class about Facilities

a) On the first day of the course the general orientation should include such information as the class needs on the location and use of facilities and conveniences for class use.

b) It is strongly urged that the entire training staff never at any time indulge in apologies or criticisms of the classroom or laboratory facilities being used. Such remarks serve no useful purpose and can only detract from an effective program, provided that everything possible has been done beforehand to resolve existing problems with facilities. Students' comments and complaints should be given an honest response, but such comments from students should not be regarded as an excuse for staff to enlarge on the subject.

b. Classroom

1) General Features

a) Door at rear of room is preferred; this permits entry of latecomers without excessive distraction of class.

b) The classroom should be free from excessive extraneous noises, such as from construction projects, heavy traffic, or aircraft.

c) The classroom should have adequate electric power outlets (115V) for use of audiovisual equipment. The receptacles should be inspected for assurance that they are compatible with the plugs on the audiovisual projector equipment being used and adapters and extension cords secured as required.

d) Room size should be adequate for seating 18 students. In addition, it should accommodate instructor's equipment, projection equipment, and a modest number (4 to 8) of intermittent visitors.

e) The classroom should be capable of being darkened quickly and effectively for use of projection equipment or television. Room dimmer lights for indirect lighting (not striking the screen directly) are recommended in fixed training installations but can be dispensed within a field training situation.

2) Student Facilities

a) Ideally, students should be seated at tables with all seats facing the instructor's area at the front of the classroom. Each student should be allocated 30" or more of table width. The sidearm chairs so familiar in the classrooms of secondary schools and colleges may be used if absolutely necessary but are distinctly inferior to tables for student work.

b) Students seating should be at least two screen widths from the projection screen (assuming a 6' screen, no student closer than 12' from the screen) and not more than 6 screen widths from the screen (again assuming a 6' screen, no student more than 36' from the screen). Furthermore, all students should be seated within a 30° angle to the left and to the right of a line from the middle of the projection screen to the projector.

3) Classroom Instructional Facilities

   a) Lectern, either freestanding or table-type, suitable for standing instructor.

   b) Demonstration table at front of classroom, approximately 3' x 5'.

   c) Chalkboard, at least 3' x 5' (preferably larger), with chalk, erasers, and pointer.

   d) Audiovisual equipment

      (1) Public address system (optional but recommended), having lavaliere microphone with adequate cord length to permit instructor to move about at front of classroom with relative freedom.

      (2) Projection screen (for size consideration see 2) b above), matte, beaded, or lenticular surface.

      (3) Projector, 35-mm slide projector for slides mounted in cardboard or plastic mount; carousel type preferred. Should have projection lens with cord length suitable for use from rear of room.

      (4) Projector, overhead type for use with overhead transparencies of approximately 7" x 9" in size.

      (5) Cassette-type playback unit, with cuing feature for automatic operation of cassette-type slide projector; compatible with National Training and Operational Technology Center (EPA) tape/slide instructional units.

      (6) Television tape playback unit (3/4" cassette type, "U-Matic" or equivalent).

      (7) Television receiver, commercial type, color, 19' diagonal picture, or larger; At least one receiver, preferably two.

c. Laboratory

1) General Features

   a) Should be well-lighted, adequately ventilated. It is particularly important that the laboratory be free from strong drafts in student working areas.

   b) Should provide for students to stand at laboratory benches which are approximately 36" from floor to bench surface.

   c) Conventional laboratory services should be available at student work areas, including electricity (115 V), gas, and vacuum.

d) Space between benches should be adequate for students to work without interfering with each other and should permit free movement of instructors in the student working area.

e) Safety features of the laboratory should be checked, including location and condition of first aid kits, fire extinguishers, emergency showers, eye-wash facilities, and other emergency equipment.

2) Student Facilities

a) Provide at least 6' of bench width per student pair. While students will work in pairs to the extent that they will share certain limited equipment, each student will perform all tests and measurements.

b) Provide bench space or floor space as necessary for laboratory equipment described in the equipment and supply lists, such as balances, ovens, waterbaths and other items not assigned to individual student work.

3) Laboratory Instructional Facilities

a) A chalkboard and demonstration table are recommended.

b) Provide at least 20 square feet for reserve supplies and equipment of each instructor.

c) For field courses, provide area for packing, unpacking, and shipping of equipment. This should be at least 100 square feet of floor space with at least 20 square feet of table space.

d. Security

Valuable property is used both in the classroom and in the laboratory. Some of the items are particularly susceptible to theft. Accordingly:

1) Provide for locking of both classroom and laboratory when not in use or assure that adequate security is provided in the facility by other means.

2) Be sure that the necessary keys are available to the instructional staff at their need.

3) With field courses, it is often necessary for the training staff to work in the evening or weekends to prepare for coming classwork. Arrangements must be made well in advance to secure authorized entry to the training facilities being made available by a host organization.

4) Thefts during normal working hours may be a special problem. Maintain surveillance to the extent practical and keep out-of-service theft-prone items out of exposed locations.

3. Laboratory Equipment and Supply Requirements for the Staff Guide of the EMP

The consolidated list in this section is for overall planning purposes. For day-to-day laboratory requirements, see the "Equipment and Supply" requirements in each Instructional Package Worksheet (IPW) contained in Part B of this Staff Guide.

The equipment list is in four sections, each related to the requirements of one of the areas of instruction (mathematics, chemistry, microbiology, laboratory inventory). In most cases, individual items of equipment or supply are not subject to shared use in two or more areas of instruction. In the few cases where this does occur, and the item is to be used for more than one purpose, this is indicated in the "remarks" column. Each of the sections, in turn, is divided into three subsections: capital equipment representing more than $100 unit purchase cost, reusable equipment of less than $100 original purchase cost, and consumable equipment having less than $100 original cost. (These prices can be taken only as approximations). Items in the list are described in the language and specifications required for ordering the item from commercial catalogs. The second column lists the minimum quantity per student required for each procedure as taught in the course. The third column lists the minimum quantity for a class of 15 students. The fourth and final column contains remarks that may be useful when deciding on class needs or when ordering equipment and supplies. Many Instructors plan for an additional margin of at least 10% of extra supplies to provide for student errors, planning miscalculations, or other unforeseen events.

It is necessary that one checks out the laboratory prior to using the list in this section. This is recommended since the safety equipment in different laboratories varies, such as the fume hood types, fire extinguisher types and first aid kits. It should also be noted that the equipment and supplies were derived from demonstrations that have been performed in the past. If these demonstrations are changed at the discretion of the Instructor, these of course, would be changed.

A list of this type can be of great value in pre-course planning, to determine the availability of needed equipment and supplies, and to take action to provide needed resources. Further, this list can be of vital importance when planning for courses to be conducted in field locations. Copies of the list in the hands of the Course Coordinator, and a representative of the host organization, can be used to determine which will provide needed resources on an item-by-item basis. When the responsibility is assigned and accepted, this can be annotated in the "remarks" column, with a copy of the annotated list in the hands of the Course Coordinator, and a copy for the representative of the host organization. Each can then use the annotated equipment and supply list as a checklist for carrying out his own agreed-upon responsibilities in preparing for the course.

I. EQUIPMENT FOR MATHEMATICS MODULE

DESCRIPTION	QUANTITY	REMARKS
Metric Conversion Table	1 per student	None
Wall Chart of Metric System	1 for classroom	

II CHEMICAL LABORATORY EQUIPMENT AND SUPPLY REQUIREMENTS

A chemical laboratory should be provided and equipped with the following:

A. Safety Shower
B. Eye Wash
C. Fire Extinguishers, both Carbon Dioxide and Dry Chemical Type
D. Fire Blankets
E. General First Aid Kit
F. Fume Hood
G. Safety Glasses for 15 students

A. CAPITAL EQUIPMENT (More Than $100 Unit Value)

Key to Abbreviations for Lessons:

N - Notebooks
L - Labeling
F - Formulas
C - Care and Use of Equipment
M - Matter
S - Solutions
B - Balances
V - Volumetric Analysis (Dissolved Oxygen)

DESCRIPTION	QUANTITY FOR: EACH LESSON	CLASS OF 15	REMARKS
Balances, analytical, 0.1 mg sensitivity at a load of 200 g. (with Instruction manuals)	BV 1	3	Also for advance preparation of reagents
Balance, trip, 500 gram capacity	BV 1	4	
Distilling apparatus, water still, all-glass or block tin	DO 1	1	Also can be used to prepare distilled water for the other lab procedures.
Hot plate, magnetic stirrer, platform area about 5 1/2" by 7", with magnet	CV	3	For advance preparation of reagents

DESCRIPTION	QUANTITY FOR: EACH LESSON	QUANTITY FOR: CLASS OF 15	REMARKS
Vacuum Sources: preferably a central service. An electric vacuum pump assembly with suitable hoses, water traps and shut off valves capable of drawing 15 inches mercury is acceptable.	C 1	8	See Lesson 5

B. REUSABLE EQUIPMENT (Less Than $100 Unit Value)

DESCRIPTION	QUANTITY FOR: EACH LESSON	CLASS OF 15	REMARKS
Aprons, laboratory	All 1	15	
Beakers, glass, 25 ml	CMSV 1	15	
Beakers, glass, 50 ml	CMSV 1	15	
Beakers, graduated, glass, 150 ml	CMSV 1	15	
Beakers, glass, 250 ml Beakers, glass, 600 ml	CMSV 1 CMSV 1	15 15	
Bottles, glass, BOD, 300 ml glass stoppers	DO 1	30	
Bottles, glass, reagent, 250 ml, with glass stoppers for all but one which requires a rubber stopper.	DO 6	10	
Bottle, glass, reagent, 2 liter with glass stopper	DO 1	1	To contain standardized sodium thiosulfate solution.
Bottles, polyethylene, aspirator with spigot, 5 gallon, screwcap, to dispense distilled water	All 2	2	
Brushes, assorted for cleaning glassware	CMV	7	
Brushes, balance	B 1	3	
Bulbs, pipet, large	V 1	7	

DESCRIPTION	QUANTITY FOR: EACH LESSON	CLASS OF 15	REMARKS
Burets, 50 ml, 0.1 ml graduations, teflon stopcock plug preferred	V 1	15	
Clamps, buret, for titration stand	V 1	15	
Crucibles, Gooch, porcelain 25 or 40 ml capacity	V 1	15	
Crucible holders, Walter, for 25 ml porcelain Gooch crucibles to fit 1 liter filter flask	V 1	15	
Cylinders, graduated, 25 or 50 ml	V 1	15	
Cylinders, graduated, 100 ml	CV	15	
Cylinders, graduated, 250 ml	C	15	
Cylinders, graduated, 1 liter	C	15	
Desiccators with effective desiccant and to accomodate 18 - 90 mm dia. watch glasses plus 18 - 20 ml Gooch crucibles.	B x	x	x - number of desiccators needed depends on their size
Flask, Erlenmeyer, wide mouth, 250 ml	CV	15	
Flask, Erlenmeyer, wide mouth, 500 ml	CV	15	
Flasks, filtering (suction), heavy glass all with side tube for hose connection and mouth to fit No. 8 stoppers, 1000 ml.	CV	15	

DESCRIPTION	QUANTITY FOR: EACH LESSON	CLASS OF 15	REMARKS
Flask, volumetric, 100 ml, with glass stopper	CVM 1	7	
Flask, volumetric, 250 ml, with glass stopper	CVM 1	7	
Funnels, short stem, diam. about 75mm (to fill 25 ml buret)	V	15	
Pipets, dropping (medicine droppers), with bulb, about 1 ml volume	V	15	
Pipets, measuring, Mohr, glass, 5 ml graduated in 1/10	CV	15	
Pipets, volumetric transfer, one ml	CV	15	
Pipets, volumetric transfer, 20 ml	CV	15	
Spatula, medium size	CMSV	15	
Sponges for cleaning bench top	CMBS	15	
Stands, titration, support for buret	CVM	15	
Stoppers, rubber, size 8, with hole for funnel filter holder	B	15	Size of hole depends on type of Funnel filter holder used
Tongs, crucible	CV	15	
Tubing, rubber 2-3 foot lengths, 3/16" I.D. by 3/32" wall for vacuum flasks	CV	15	

DESCRIPTION	QUANTITY FOR: EACH LESSON	CLASS OF 15	REMARKS
Wash bottles, squeeze type 500 ml	CMV	15	
Watch glasses, 90 mm dia.	C	15	

C. CONSUMABLE SUPPLIES

DESCRIPTION	QUANTITY FOR: EACH LESSON	CLASS OF 15	REMARKS
Detergent, in small boxes or jars at sinks	SV	3	
Filter discs, glass fiber without organic binder, Reeve Angel 934H or 984, Gelman Type A, Watman GF/C or equivalent. Size should cover holes in funnel filter holders to be used (∼ 5 cm. dia.) and also to fit 25 ml Gooch crucibles (∼ 2.1 cm. dia.)	V	30	
Lubricant, silicone (stopcock) small tubes	V	7	
Labels, lead pencils, grease pencils, Vibragroover and marking ink supply to mark glass and porcelain	LCV	15	
Notebooks, to record data	All	15	
Pens, felt tip, to mark beakers, watch glasses, etc.	All	15	
Pencils, wax marking			See microbiology Section
Weighing boats, disposable	BV	50	
Reagents, Dissolved Oxygen, Winkler Method:			For preparations according to 1974 EPA Manual, p. 53 All reagents should be prepared PRIOR to student lab sessions.
Alkali-iodide-azide solution: 500 g/l sodium hydroxide 135 g/l sodium iodide 10 g/l sodium azide	V	250 ml	

DESCRIPTION	QUANTITY FOR: EACH LESSON	CLASS OF 15	REMARKS
Chloroform	V	15 ml	
Manganous sulfate solution:			
480 g/l manganous sulfate tetrahydrate	V	250 ml	
Potassium biiodate solution:			
4.873 g/l potassium biiodate	V	250 ml	
Potassium iodide crystals	V	6 g	
Sodium thiosulfate stock solution:			
186.1 g/l sodium thiosulfate pentahydrate	V	250 ml	
Starch solution:			
10 g/l soluble starch	V	250 ml	
Sulfuric acid, concentrated	V	250 ml	

The following reagents are needed for the demonstration. These are listed and coded Table 1, 2, 3, and 4.

CHEMICAL REAGENTS

Table #1

$MnSO_4 \cdot H_2O$	Manganous Sulfate Monohydrate
NaI	Sodium Iodide
NaN_3	Sodium Azide
	Soluble Starch (Corn)
NaOH	Sodium Hydroxide (Pellets)
$Na_2S_2O_3 \cdot 5H_2O$	Sodium Thiosulfate Pentahydrate
$KH(IO_3)_2$	Potassium Bi-iodate (Potassium Acid Iodate)
KI	Potassium Iodide
$Na_2S_2O_3$	Sodium Thiosulfate Anhydrous
$MgSO_4 \cdot 7H_2O$	Magnesium Sulfate Heptahydrate
$NaIO_3$	Sodium Iodate
KIO_3	Potassium Iodate
NaOH in Solution (6N) Reagent	6N NaOH Sodium Hydroxide

CHEMICAL REAGENTS

Table #2

$MgSO_4 \cdot 7H_2O$	Magnesium Sulfate Heptahydrate
K_2HPO_4	Potassium Phosphate, Dibasic Dipotassium Hydrogen Phosphate
$FeCl_3 \cdot 6H_2O$	Ferric Chloride Hexahydrate
$CaCl_2$	Calcium Chloride Anhydrous
$FeCl_2 \cdot 4H_2O$	Ferrous Chloride Tetrahydrate
Na_2HPO_4	Sodium Phosphate, Dibasic - Anhydrous or Disodium Hydrogen Phosphate
KH_2PO_4	Potassium Phosphate, Monobasic or Potassium Dihydrogen Phosphate
$Na_2HPO_4 \cdot 7H_2O$	Sodium Phosphate, Dibasic - Heptahydrate or Disodium Hydrogen Phosphate
$Na_2HPO_3 \cdot 5H_2O$	Sodium Phosphite, Dibasic - Pentahydrate or Disodium Hydrogen Phosphite
$CaCl_2 \cdot 2H_2O$	Calcium Chloride Dihydrate
NH_4Cl	Ammonium Chloride
K_3PO_4	Potassium Phosphate, Tribasic

CHEMICAL REAGENTS

Table #3

KNO_3	Potassium Nitrate
KNO_2	Potassium Nitrite
HCl	Hydrochloric Acid (6N) Dilute
HCl	Hydrochloric Acid Concentrated
$NaAsO_2$	Sodium Arsenite (META)
$Na_2HAsO_4 \cdot 7H_2O$	Sodium Arsenate, Dibasic Heptahydrate or Disodium Hydrogen Arsenate Heptahydrate
$NaCl$	Sodium Chloride
NH_2SO_3H	Sulfamic Acid
$NH_2C_6H_4SO_3H \cdot H_2O$	Sulfanilic Acid

CHEMICAL REAGENTS

Table #4

C_2H_5OH (95%)	Ethyl Alcohol or Ethanol
Sulfuric Acid (6N)	Dilute H_2SO_4
Sulfuric Acid 18N	Concentrate
H_3BO_3	Boric Acid
HgO	Mercuric Oxide; red Mercuric Oxide; yellow
$Na_2S_2O_3$	Sodium Thiosulfate, Anhydrous
NaSCN	Sodium Thiocyanate
NaOH	Sodium Hydroxide (pellets)
K_2SO_4	Potassium Sulfate
$K_2S_2O_7$	Potassium Pyrosulfate
Methylene Blue, Alsoholic Solution Staining and Powder	
Methyl Blue - Powder	
$C_{15}H_{15}N_3O_2$	Methyl Red - Solution and Powder Solution 0.02% in 60% Alcohol or (p) Para - Dimethylaminoazobenzene -O- Carboxlic Acid

CHEMICAL REAGENTS

Potassium Dichromate

Potassium Hydroxide Cleaning Solution

Sodium Chloride (approximately 200 gms to be used as samples for the students doing their weighing)

III. BACTERIOLOGY LABORATORY EQUIPMENT AND SUPPLIES REQUIREMENTS

A. CAPITAL EQUIPMENT (More than $100 Unit Value)

	QUANTITY FOR:		
DESCRIPTION	MPN	MF	REMARKS
Autoclave, providing uniform temperatures up to and including 121°C, equipped with an accurate thermometer, pressure gauges, saturated steam power lines and capable of reaching desired temperature in 30 minutes.	1	1	
Balance, 0.1 g sensitivity at a load of 150 g	4 - 6	4 - 6	
Funnel Unit, membrane, unit assembly, sterile, equipped with No. 8 rubber stopper to fill 1-liter vacuum flask.	-	9	
Incubator with saturated relative humidity, adjusted to 35 ± 0.5°C and to accommodate a minimum of 18 culture tube racks (approximately 6" X 12" each).	1	-	
Incubator, waterbath, adjusted to 44.5 ± 0.2°C and to accommodate 5 to 10 tube racks (approximately 6" X 12" each).	1	1	
Microscopes, steroscopic, magn. 10X or 15X binocular type preferred.	-	1	

DESCRIPTION	QUANTITY FOR: MPN	 MF	REMARKS
Oven, hot-air sterilizing, to give uniform temperatures and with suitable thermometers to register accurately in range of 160-180^{o}C	1	1	
pH meter, electrometric, accurate to at least 0.1 pH unit	1	1	
Refrigerator: Operates at 6^{o} - 10^{o}C	1	1	Temporary sample storage, storage of MF media, reagents. Not for storage of MPN media.
UV light to resterilize funnels if necessary	-	-	Optional
Vacuum Service: preferably a central service. An electric vacuum pump assembly with suitable hoses, water traps, and shut-off valves is acceptable. As a last resort, but not recommended, use a water aspirator or hand-pump.	-	X	Service to 9 lab work positions.

B. REUSABLE SUPPLIES and Durable Property of Less than $100 Unit Value

DESCRIPTION	MPN	MF	REMARKS
Aprons, laboratory (plastic acceptable)	18	18	
Baskets for discarded cultures	9	9	
Beakers, 400-600 ml	9	9	
Bottles, dilution, 6 oz., preferably borosilicate glass, with screw cap (or rubber stopper protected by paper) with 99 ml volume etched on side.	48	72-144	
Bottle, mixing, 4 liter, wide-mouth borosilicate glass	2	3	
Bottles, sample, 250-ml wide mouth, glass stopper	10	20	
Bottles, squeeze, for disinfecting solution	9	9	

DESCRIPTION	MPN	MF	REMARKS
Bottles, wide-mouth (for about 20 ml. methanol to sterilize forceps)	-	9	
Burners, gas	9	-	
Cans, pipet, aluminum or steel, not copper. (If plastic, disposable pipets are used, this item is not necessary.)	18	18	Not necessary if single-service glass or plastic, pre-sterilized, wrapped pipets are used.
Caps to fit 20 X 150 mm culture tubes	800	-	
Clamps, pinchcock, strong enough for tight compression of vacuum tubing	9	9	
Cylinders, 100 ml graduated, sterile	-	9	
Filters, membrane, white, grid marked, sterile pore size suitable for bacterial retention, (usually about 0.45 micron) in units of 10 filters per package.	-	200	20 packages of 10 filters/package
Flasks, Erlenmeyer type, 250 ml; borosilicate glass.	-	9	

DESCRIPTION	MPN	MF	REMARKS
Flasks, suction, glass, 1 liter, mouth to fit No. 8 stopper	-	9	
Forceps, curved-end round tipped, for MF work	-	18	
Funnels, glass, 4-6" diameter. Borosilicate	9	-	
Hot plates, electric, thermoregulator	-	9	Alternately, use tripod with gas burner.
Jars to receive used pipets.	9	9	
Lamp, fluorescent, for dissecting microscope	-	9	
Loops, inoculation, 3 mm diameter loop of nichrome or platinum - iridium wire, 26 B&S gauge, in suitable holder	18	-	
Pads, absorbent (for nutrient), 47 mm in diameter, sterile, in units of 10 pads per package	-	200	Usually supplied with the membrane filters.

DESCRIPTION	MPN	MF	REMARKS
Pipets, 1 ml with 0.1 ml graduations, Mohr type preferred, sterile, cotton plugged, glass or disposable plastic. Quantity given is minimum number required. Each pair of students should be given a can with 10-12 glass pipets or else a package of a dozen plastic pipets.	48	18	
Pipets, 10 ml graduated, Mohr type preferred, sterile, cotton plugged, glass or disposable plastic. Again, this is a minimal quantity. Each student pair should be given a can with glass pipets or else a surplus of the individually packed plastic pipets.	18	72-80	
Racks, culture tube, 10 X 5 openings to accept tubes of 25 mm diameter, minimum	24	18	
Ring stand; to accommodate 4 - 6" glass funnels	9	-	
Sponges for cleaning desk tops	9	9	

DESCRIPTION	MPN	MF	REMARKS
Tallies, hand, single unit acceptable, hand or desk type	-	9	
Thermometer (for use in incubator water bath). Must indicate in the 40^0 - 50^0C range and have increments of 0.1^0C. Should be NBS certified or calibrated against NBS certified thermometer. Full Immersion type preferred.	1	1	
Thermometer (for use in sterilizing oven). Must indicate within the 160 - 180^0C range and should have increments at least 1.0^0C.			
Thermometer (for use in 35^0C incubator). Must indicate in the 30 - 40^0C range and have increments of at least 1.0^0C. Should be NBS certified thermometer. Best used with bulb immersed in water, glycerine, or oil fitted in flask or bottle with rubber stopper.	1	-	
Tongs, crucible (to fit culture tubes)	-	9	
Tubes, fermentation, 12 X 75 mm vials to be inverted in culture tubes	800	-	

DESCRIPTION	MPN	MF	REMARKS
Tubes, culture, 20 X 150 mm	660	-	
Tubing, rubber, 2-3 foot lengths, latex rubber, 3/16" I.D. by 3/32" wall (for vacuum flask).	-	9	

C. CONSUMABLE RESOURCE SUPPLIES

These items will either (1) be used directly by the student, (2) be used by staff in preparing solutions and media described in following section.

DESCRIPTION	MPN	MF	REMARKS
Bags, waterproof plastic, 3 X 7-1/4" for culture dish incubation	-	36	
EC Broth, dehydrated; Difco, BBL, or equivalent, in 1/4-lb. bottles.	4-6	-	Do not buy 1-lb. bottles.
Dishes, Petri, 50 X 12 mm, sterile, plastic or glass.	-	120	Most workers use plastic Petri dishes.
Iodine, crystals, 1/4-lb. bottle	1	1	For preparation of disinfectant solution.
Lactose Lauryl Sulfate Tryptose Broth; BBL, Difco, or equivalent. Dehydrated. 1-lb. bottle.	1	-	
M-FC Broth, Dehydrated; BBL, Difco, or equivalent. 1/4-lb. bottles.	-	4-6	Do not buy 1-lb. bottles
Methanol (for sterilizing forceps), 20 ml amounts in 12 wide mouth bottles.	-	9	

DESCRIPTION	MPN	MF	REMARKS
Potassium dihydrogen phosphate (KH_2PO_4) 1/4-lb. bottle.	1	1	For preparation of dilution water.
Potassium Iodide (KI), crystals, 1/4-lb. bottles.	1	1	For preparation of disinfectant solution.
Pencils, china-marking, wax	18	18	
Rosolic Acid, powdered, 1-gram units	-	1	
Sodium Hydroxide (NaOH) pellets, 1/4-lb. bottle.	1	1	
Water, distilled or deionized. Suitable for use in bacteriological culture media.	20	30	Many laboratories will have their own distillation apparatus; others must use commercial sources.

D. CONSUMABLE RESOURCE SUPPLIES (requiring staff preparation)

These items will require preparation by staff, in advance of the course. Materials for preparation and containment of these items should, without exception, be listed in foregoing lists of equipment and supplies.

DESCRIPTION	MPN	MF	REMARKS
Dilution water, sterile, 99-ml blanks, in 6-oz. screwcapped bottles, with mark at 99-ml mark.	48	72-144	
Dilution water: for class samples.	2	2	Prepare 3 liters of sterile dilution water in 4-liter glass bottles. On appropriate class day(s), deliver appropriate amount of fresh domestic sewage to the dilution water. See special instructor's notes for the lessons.
Iodine-Potassium Iodide Solution, consisting of 3 grams Iodine crystals, 6 grams Potassium Iodide crystals, dissolved in 3 liters distilled water, and dispensed in plastic squeeze bottles.	1	1	

DESCRIPTION	MPN	MF	REMARKS
Lactose Lauryl Sulfate Tryptose Broth, 10-ml portions of single-strength medium, 10-ml portions in 20 X 150 mm culture tubes with fermentation vials, metal caps. Sterile.	400	-	
Sodium Hydroxide solution, 0.2 N	-	200 ml	For preparing 1% Rosolic Acid solution.
Sodium Hydroxide Solution, 1 N	1 liter	1 liter	For preparing stock solution phosphate buffer for dilution water.

IV. Laboratory Inventory Equipment and Supplies

A. Capital Equipment: None

B. Reusable Supplies:

A supply of commerciably available catalogs from chemical supply houses is necessary. This is left to the discretion of the Instructor.

4. Instructional Resources

a. Introduction

Most training institutions will make the fullest possible use of pre-existing instructional resources. The purpose of this section is to describe the nature, sources, and availability of instructional resources suggested for use with this course.

1) The Instructional Package Worksheets (IPWs) in Part B of this Manual and the student reference text refer to a number of different instructional resources.
These include:

   a) The student reference text itself;

   b) Audiovisual training aids; and

   c) Supportive references

2) Instructional resources are discussed in this section from the viewpoint of the sources of the materials:

   a) Resources developed by United States Environmental Protection Agency (U.S. EPA)

   b) Resources developed by other sources; and

   c) Resources already in possession of the training institution conducting this course.

b. Instructional Resources Developed by U.S. EPA

1) Student Reference Text and Staff Guide for the course "Effluent Monitoring Procedures: Basic Laboratory Skills":

   a) While present supplies last, a sample copy (can be duplicated) is available on specific request to:

National Training and Operational Technology Center
ATTN: Training Information Clerk
U.S. Environmental Protection Agency
Cincinnati, Ohio 45268

   b) NTOTC has negatives of the Text and Guide which are available for temporary loan on request of a sponsoring Agency wishing to duplicate the materials.

2) Audiovisual Training Aids Developed for the Course:

a) What is available according to topic:

(1) Basic Mathematics

Effluent Monitoring Procedures: Basic Laboratory Skills
CCCC Metric Conversion Table, GPO
Mathematics, A Basic Course, Dever & Salten, CAM
Basic Mathematics Vol. 1-V, Daniel Borrow, EBEC
A Guide to Remedial Instruction in Basic Mathematics, Gay, Count, Ponder, GREEN
Metric System of Linear Measure (821), CSC
Elementary Mathematics and Basic Calculations, Eglof & Swope, WSW
Modu-Math Video Cassette Math Course, SUNY
See 9-3 and 9-4 for Code Explanations

(2) Chemical Laboratory

Standard Methods for the Examination of Water and Wastewater, 14th ed. (No. 10004), AWWA, APHA, ASCE, WPCF
Laboratory Procedures, Nagan, CWPCA
Safety in the Chemical Laboratory, Norman Steere, CHED
Effluent Monitoring Procedures: Basic Laboratory Skills, CCCC
Safety in the Laboratory, KM
Titration and Its Glassware (51), DuPont, EID
Water Treatment--Water Chemistry (90), DuPont, EID
Laboratory Procedures for Wastewater Treatment Plant Operators, NY Department of Health, HES
Laboratory Procedure for Wastewater Analysis (No. 3), NERWI
Self-Monitoring Procedures: Basic Parameters for Municipal Effluents, EPA-2
Common Laboratory Apparatus (811), CSC
Pipetting Techniques (812), CSC
How to Titrate Using a Buret (8105), CSC
The Buret (Basic Principles) TC-5, EPA-2
Basic Chemistry for Water and Wastewater Personnel--Manual, MI Department of Health, MPH
Winkler Determination of Dissolved Oxygen, EPA-2
Standardization of Sodium Thiosulfate, EPA-2

(3) Microbiology

Water Pollution Microbiology, R. Mitchell, WI
Self-Monitoring Procedures: Basic Parameters for Municipal Effluents, EPA-2
Current Practices in Water Microbiology, EPA
Self-Monitoring Procedures: Basic Laboratory Skills, CCCC

(4) Laboratory Equipment

Several Scientific Catalogs

The sources that are referred to are listed beginning on page 9-3, indicating the source for the various types of media.

SOURCE LISTINGS

SOURCE	TITLE
OKBS	Oklahoma State University Book Store Stillwater, Oklahoma 74074
BPC	Burgess Publishing Company 7108 Ohms Lane Minneapolis, MN 55435
SDA	The Soap and Detergent Association 475 Park Avenue South New York, New York 10016
CuSC	Marketing Department Curtin Scientific Company P.O. Box 1545 Houston, Texas 77001
InNi	The International Nickel Company, Inc. 1 New York Plaza New York, New York 10004
CVM	C. V. Mosby Company 11830 Westline Industrial Drive St. Louis, Missouri 63141
AEEP	AEEP c/o Dr. Joe Molina Director of Environmental Health Engineering 305 Engineering Building University of Texas Austin, Texas 78712
WHF	W. H. Freeman & Company San Francisco, California
GREEN	Greenville Technical Education Center Greenville, South Carolina 29606
CAH	Cambridge Book Company New York, New York
ACS	American Chemical Society 1155 16th Street, NW Washington, DC 20036
CHED	Division of Chemical Education American Chemical Society Easton, Pennsylvania 18042

SOURCE LISTINGS

SOURCE	TITLE
DCH	D. C. Health & Company Lexington, Massachusetts
CCCC	Charles County Community College P.O. Box 910 La Plata, Maryland 20646
KM	Kalmia Company Concord, Massachusetts 01742
CRC	Chemical Rubber Company Cleveland, Ohio
VP	Villanova Press Villanova, Pennsylvania 19085
NSC	National Safety Council 425 N. Michigan Avenue Chicago, Illinois 60611
NFPA	National Fire Protection Association 60 Batterymarch Street Boston, Massachusetts 02110
BNA	Bureau of National Affairs, Inc. 1231 25th Street, N.W. Washington, DC 20037
NIH	National Institute of Health Safety and Fire Prevention Branch Bethesda, Maryland 20014
WI	Wiley Interscience John Wiley & Sons, Inc. 605 Third Avenue New York, New York 10016
SUNY	New York Network A. E. Smith Office Bldg. - 12th Floor Albany, New York 12225 Attention: Mr. Dan Sweeney
EPA - 2	Ms. Eileen Hopewell U.S. EPA, OWPO National Training & Operational Technology Center Cincinnati, Ohio 45268

3) Supportive References:

a) Manual: EPA-EMSL, "Methods for Chemical Analysis of Water and Wastes". This is the reference source of all the methods presented in this course in the Effluent Monitoring Procedure (EMP) format. Address requests for a copy to:

U.S. EPA
Office of Technology Transfer
Industrial Environmental Research Laboratory
Cincinnati, Ohio 45268

b) AV Catalog: NTOTC, "Audiovisual Instructional Units". This is a catalog of slide-tape instructional units developed by the Center. Although not developed specifically for this course, several of the units are on course topics and might be useful supplementary material. Address requests for a copy to NTOTC at the address given in b. 1) a), above.

c) IRIS: A Water Quality Instructional Resources Information System has been developed through an EPA training grant. The "Master Reports" contain availability information and descriptions for 2300 entries of instructional and resource materials. These are printed matter, slides, films, slide-tape units and video tapes developed by varied sources for training personnel involved in all aspects of water quality assessment and control. Thus, IRIS serves as an information source of available water quality training resources covering a wide range of subjects.

The user does not need data processing equipment to use the system. Four of the commonly used elements of IRIS (Users Manual, Tables, Master Report, Subject Index) are currently available.

(1) While present supplies last, a set is available to qualifying educational institutions and training agencies from NTOTC at the address given in b.1)a).

(2) Paper copies can be ordered as a set of four volumes from NTIS (PB-262-223/AS, Set, 1120 pp. "Water Quality Instructional Resources Information System, Volumes I through IV) for $31.00. The NTIS address is given in b.1)c), p. 9- . Microfiche copies cost $12.00 per set.

(3) Paper or microfiche copies of individual volumes can also be ordered from NTIS at the address given in b.1)c) using this information:

(a) PB-262-224/AS, 99 pp., "Water Quality Instructional Resources Information System, Volume I-Users Manual" @ $5.00. (microfiche $3.00)

(b) PB-262-225/AS, 96 pp., "Water Quality Instructional Resources Information System, Volume II-IRIS Tables" @ $5.00. (microfiche $3.00)

(c) PB-262-226/AS, 494 pp., "Water Quality Instructional Resource Information System, Volume III - Identification Number Master Report" @ $12.50. (microfiche $3.00)

(d) PB-262-227/AS, 431 pp., "Water Quality Instructional Resources Information System, Volume IV - Subject Index" @ $11.75. (microfiche $3.00)

c. Instructional Resources Developed by Other Sources

1) Minimum technical references which should be in possession of the institution include:

a) "Standard Methods for the Examination of Water and Wastewater" (14th ed), APHA, AWWA, WPCF. Available from Publications Office, American Public Health Association, Inc., 1015 18th Street, NW, Washington, D.C. 20036.

b) "Annual Book of Standards" Part 31, "Water", 1975. Available from American Society for Testing and Materials, 1916 Race St., Philadelphia, PA 19103.

2) Audiovisual and Other Training Aids

a) A wide variety of training resources is listed in the EPA sponsored publication, "Water Quality Instructional Resources Information System" (IRIS), cited in b, 3) c), page 9-5.

b) Information on sources of the listed items is provided.

c) Training institutions having information about training resources applicable to this course which are not currently listed in IRIS, are invited to relay this information to the Director, National Training and Operational Technology Center. Such resources, as applicable, will be made known to other organizations which could benefit from their use.

d. Instructional Resources Already in Possession of the Training Institution

1) Many training organizations prefer to develop their own texts and audiovisual training resources.

2) To the extent that these resources can be released for free reproduction and use by others, institutions are invited to make such resources available to other training organizations.

3) The National Training and Operational Technology Center is prepared to serve as a focal point for making information about such resources widely available, provided that copyright or other restrictions on reproduction do not limit availability of such materials.

a) Before encouraging other training institutions to use such resources in relation to this Course, elements of EPA will:

(1) Review the training resources to determine whether the instruction is consistent with existing laws, regulations, and Agency policy;

(2) Review the resource for technical validity and educational quality.

b) Materials found suitable by EPA would be recommended to other institutions known to be presenting this Course.

4) All training resources referred to NTOTC as available for use by others will be added to the overall inventory listing cited in IRIS, b. 3) c), page 9-5. It is hoped that a mutually supportive activity in this area will in time result in:

a) making IRIS a diversified, total resource system for training materials which will be of the highest technical quality;

b) offering training institutions a wide variety of types of training resources;

c) reducing the amount of duplication of effort that so often results from lack of information on what is available, from what sources, and how it can be obtained.

C. Secretarial Support

The key role of the office worker(s) designated "Course Secretary" cannot be overemphasized.

This function has many elements, including being the right arm of the Course Coordinator, being Course Registrar, being Course Secretary and being a "Course Watchdog" to give the alarm when essential milestone stages of course planning and preparation are being overlooked.

In this section these elements are considered under the headings: Course Records and Record-keeping, Suggested Student Registration Procedures and Printed and Reproduced Materials - Summary.

1. Course Records and Record-keeping

a. General Considerations

1) Complete, detailed, and accurate records should be established for each course presentation. Each course record will be a separate file. In addition to the individual course files, it may be necessary to establish a finder-system for locating the records of individual students.

2) Response to Inquiries about Former Students

a) Students enroll in this course in order to acquire necessary knowledge and skills to perform the self-monitoring procedures required for municipal effluents.

b) In many if not all cases, satisfactory completion if this course will be a factor in the accreditation of individuals to perform the analyses and measurements required for compliance with NPDES Permits.

c) It is anticipated that numerous inquiries from former students and from regulatory agencies will be addressed to the training institution. Typical requests for information may include any or all of the following:

(1) Verification of attendance and satisfactory completion of training;

(2) Identification of the specific analyses and measurements covered in the course, as well as designation of the method which was taught;

(3) Quality of student performance in the course;

(4) Documentation of any specific analyses, tests, or measurements in which the student did not meet the required standard of performance and the nature of such failure; and

(5) Documentation of any other events which made the student unusual. This could be a record of exceptionally high performance, or it could be a record of any specific difficulty which arose in connection with the student, within or outside the scheduled training activities.

3) Reports

Most training institutions require submission of periodic reports on progress and achievements. It is safe to predict that from time to time management or cognizant regulatory agencies will call for information not provided in routine reports. If such demands are to be met, complete course records will be the most reliable source for such information.

4) Retention of Records

The length of time that course record files should be retained is uncertain and must be determined by each institution.

Institutions having a system of archieves for inactive files may find it convenient to retain course records in active office files for approximately two years, then retire them to archieves storage. Institutions not having archives storage probably should retain the complete file on each course presentation for at least five years.

b. Contents of Course Files

1) In the planning and development stage and until completion of each course presentation, course records are kept most effectively in two sections.

These are:

a) A file folder, kept in the filing cabinet or in the desk of the Course Secretary; and,

b) A student record notebook, usually a 3-ring binder, kept on the Course Secretary's desk or in a convenient bookcase.

Both sections of the course files should be maintained by the Course Secretary and should be made available to other staff members under rigid controls providing for direct examination and immediate return. After completion of the course, the two sections can be combined in a single large file packet for future retention.

2) The file folder is best suited for such records as:

  a) Copies of all correspondence, memoranda, and records of telephonic conferences related to course planning and development;

  b) Copies of course schedules;

  c) Records of equipment and supply acquisition for the course, through purchase or through loan (with information and records on return to owner);

  d) Records of staff assignments, classroom and laboratory reservations;

  e) Copy of course announcement and/or description (See pages 11-5 and 11-6);

  f) Sample record copies of all routine informational material sent to students accepted for training; (See pages 11-7 through 11-13);

  g) Records of arrangements for travel of personnel and transportation of equipment and supplies, arrangements for field facilities, and other records pertaining to a field course;

  and

  h) Course evaluation commentaries by Course Coordinator and other staff members as appropriate.

3) The student record notebook is best suited as a vehicle for all records and copies of communications related to individual students. This may be organized effectively in a 3-ring notebook containing separator sheets with alphabetical tabs. The personal records of each student will be retained under the alphabetical tab corresponding with his last name. In the student record notebook may be found:

  a) At the front (before the "A" of the series of tabbed dividers):

    (1) A registration summary sheet showing record of standard communications with each accepted student, fees paid, etc... (See page 11-14);

    (2) A waiting list summary sheet showing a record of standard communications with each student placed on a waiting list prior to the course because of early maximum enrollment. (See page 11-15)

    (3) A non-attendance summary sheet showing a record of students who applied for admission but could not be admitted because of a lack of qualification or an already-filled class. This summary also is used to identify applicants who applied for admission, who were admitted, and who failed to appear without due explanation ("no shows"). (See page 11-16);

    (4) A summary sheet recording student performance (acceptable or not acceptable) for each of the units of instruction in the course. (Such a summary worksheet has not been developed at the writing of this Guide.)

b) In the alphabetical section of the student record notebook, each student's personal record will contain such items as:

    (1) The application for admission to training (see pages 11-7 and 11-8);

    (2) Copies of all correspondence with the student (see pages 11-10 through 11-13) except for the routine local information sheets, one set of which is kept in the loose file folder;

    (3) Record copies of student quizzes, data sheets, and other individual records of class performance provided by Instructor. (See pages 12-6 through 12-15.)

    (4) Copy of the certificate awarded at end of course which is a record of the measurements completed by the student in a satisfactory manner. (See page 11-17.);

    (5) Documentation of any information about the student judged to be of possible future concern or inquiry. (An example of such a sheet had not been developed at the time of writing this Guide.)

2. Suggested Student Registration Procedures

a. Introduction

1) Purpose

Formal registration and enrollment procedures are intended to assure that:

a) The class consists of students for whom the training is intended and designed;

b) The accepted students meet minimum knowledge and skills required for reasonable assurance of satisfactory completion of the course;

c) Accepted students are provided with adequate pre-training information so that they will make their personal arrangements and travel schedules to assure arrival at the appointed time and place, with full participation throughout the program of training;

d) The size of the class is in accordance with the course plan; and

e) Those not accepted for training are provided with suitable advice which can lead to future admission.

2) Alternative Approaches to Registration

Three different approaches to registration are considered here, though only the first is described in detail. Most details of the second and third identified alternatives can be inferred through study of the first alternative. The three approaches considered are:

a) Registration by priority of receipt of application;

b) Registration by comparative evaluation of all applicants; and

c) Registration for special course offering at request of another organization. Students are nominated by the requesting organization and are accepted without further evaluation of entry-level qualifications by the training institution.

b. Registration by Priority of Receipt of Application (Recommended)

1) Applicant

a) Receives course announcement;

b) Completes application and secures internal approvals as required in his own organization;

c) Mails application to registration office of the institution conducting the training.

2) Course Secretary

   a) Receives application;

   b) As received, checks status of registration for availability of class space and makes appropriate notation on the application or on attached transmittal slip;

   c) Depending on b), records application either in the registration summary or the waiting list summary in front of student notebook;

   d) Delivers application to Course Coordinator.

3) Course Coordinator

   a) Evaluates the student application and the space availability situation;

   b) Directs the Course Secretary by notation on the application to:

      (1) Accept the applicant, or

      (2) Notify the applicant of closed class enrollment, or

      (3) Refer the applicant to the "Basic Laboratory Skills" course before entry into this course;

   c) Prepares a special letter for non-admissable applicants (or memorandum record of other form of communication with applicant) which sets forth the reasons why the applicant is being rejected. Because of the compulsory nature of the self-monitoring tests on municipal effluents for NPDES Permit compliance, rejection of a bona fide applicant may be a very serious matter and should be handled with care.

4) The Course Secretary

   a) Prepares a standard letter or special letter as directed, and obtains signature of Course Coordinator;

   b) Places a file copy of the letter and the application in the appropriate place under the alphabetical tab section of the student record notebook;

   c) Mails the original letter to the applicant and records the date of mailing in the appropriate place in the summary records at the front of the student notebook.

   d) Approximately 30 days before the course, mails to each accepted applicant a standard communication, consisting of

      (1) A form letter of welcome to the course, including information on starting and closing dates and hours of the course, directions and how to proceed to the classroom area, and related information (See page 11-10); and

(2) Local information helpful to outside visitors, such as hotel/motel information, local transportation and schedules, a schematic map of the area, and related information. (See pages 11-10 through 11-13.);

e) Records the mailing of the standard packet on the registration summary sheet.

f) When applications are still being accepted within 30 days before the start of the course, includes the general informational material with the letter of acceptance for admission.

g) On the first day of the course:

(1) Obtains a detailed registration card from each student. Some institutions may dispense with this record, though it can be of value in report preparation. (See page 11-14.);

(2) Prepares any registration tallies required by requesting organization(s) and/or administrative regulations.

(3) Prepares a class roster of those in attendance, distributes to class and staff, and keeps a permanent record copy in course files;

(4) Records any "no shows" (applicants accepted for training but who did not appear) on the student non-attendance summary record sheet. (See page 11-16.)

c. Registration by Comparative Evaluation of all Applicants

1) Applicant

a) Receives course announcement;

b) Completes application and secures internal approvals as required in his own organization;

c) Mails application to registration office of the institution conducting the training.

2) The Course Secretary

a) Receives the applications;

b) Records receipt of application in a summary record in student record notebook;

c) Files application in student notebook;

d) Sends standardized letter acknowledging the application and briefly explaining the registration procedure, with assurance that decision on admission will be announced not less than 30 days prior to start of the course.

e) Delivers all applications to the Course Coordinator, approximately 35 days before start of the course.

3) The Course Coordinator

a) Reviews and evaluates all applications;

b) Selects students to be admitted for training;

c) Directs Course Secretary to send appropriate standardized letters and information packets as described in b., 4), d), page 11-2.

d) Special note should be taken of the particular attention which should be given to rejected applicants. See b., 3), c), page 11-2.

4) The Course Secretary

a) Sends communications;

b) Prepares records and student files as described in b.4), page 11-2.

d. Registration for Special Course Offering

Here a requesting organization has designated a student body which it wishes to have trained. It is the duty of the training institution to provide the requesting organization with admission standards for the course. It becomes the duty of the requesting organization to screen its candidates for conformance to these standards, and to provide the training institution with the names of the students to be trained. The requesting organization usually notifies the students.

1) For record purposes, it is best that students complete a course application form, though it will not be evaluated as in b. and c. above.

2) On receipt in the training institution, the Course Secretary makes the necessary entries showing record of receipt and class composition. Files are kept in the usual way. Approximately 30 days before the course, the individual standardized welcome and information packets are sent to students in the usual way. The training organization follows its usual practices in preparation of records, rosters, and any other data required for reports.

THE CHARLES COUNTY COMMUNITY COLLEGE ANNOUNCES A SPECIAL OFFERING OF THE FOLLOWING COURSES IN SELF-MONITORING PROCEDURES

COURSE I - BASIC LABORATORY SKILLS

THIS COURSE IS DESIGNED FOR THE TREATMENT PLANT OPERATOR OR TECHNICIAN WHO IS REQUIRED TO MONITOR EFFLUENT DISCHARGES UNDER A NATIONAL POLLUTANT DISCHARGE ELIMINATION SYSTEM (NPDES) PERMIT AND WHO HAS HAD LITTLE OR NO PREVIOUS EXPERIENCE IN LABORATORY WORK.

THE COURSE WILL INCLUDE A REVIEW OF BASIC MATHEMATICS. APPLICATIONS IN THE CHEMICAL LABORATORY SUCH AS WEIGHING TECHNIQUES, USE OF EQUIPMENT AND SOLUTION PREPARATION WILL BE STRESSED. AN INTRODUCTION TO BASIC MICROBIOLOGICAL TECHNIQUES WILL ALSO BE INCLUDED.

PRE-REQUISITES

ANY INDIVIDUAL WHO IS EMPLOYED AS AN OPERATOR OR A TECHNICIAN IN A WASTEWATER TREATMENT FACILITY BUT DOES NOT POSSESS THE NECESSARY SKILLS TO PERFORM THE BASIC ANALYSES, WILL BE ELIGIBLE FOR THE PROGRAM.

COURSE II - BASIC PARAMETERS FOR MUNICIPAL EFFLUENTS

THIS COURSE IS DESIGNED FOR THE TREATMENT PLANT OPERATOR OR TECHNICIAN WHO IS REQUIRED TO MONITOR EFFLUENT DISCHARGES UNDER A NATIONAL POLLUTANT DISCHARGE ELIMINATION SYSTEM (NPDES) PERMIT AND WHO HAS HAD LITTLE OR NO PREVIOUS EXPERIENCE IN WASTEWATER ANALYSIS OR FLOW MEASUREMENT.

PARAMETERS INCLUDED IN THIS COURSE ARE BOD_5, pH, FECAL COLIFORM, RESIDUAL CHLORINE, SUSPENDED SOLIDS, AND OPEN CHANNEL FLOW. AT THE CONCLUSION OF THIS TRAINING, THE STUDENT WILL BE FAMILIAR WITH THE STANDARD TEST PROCEDURE FOR EACH PARAMETER, WILL HAVE PERFORMED EACH ANALYSIS, AND WILL BE ABLE TO USE A PARSHALL FLUME OR WEIR TO MEASURE EFFLUENT FLOW. HE WILL ALSO KNOW WHAT EQUIPMENT AND SUPPLIES ARE NEEDED IN CONNECTION WITH EACH PROCEDURE.

PRE-REQUISITES

PARTICIPANT SHOULD HAVE ABILITY TO PERFORM BASIC MATHEMATICAL CALCULATIONS USING WHOLE NUMBERS, FRACTIONS AND DECIMALS. SELF-MONITORING PROCEDURES: COURSE I - BASIC LABORATORY SKILLS OR EQUIVALENT EXPERIENCE IS PRE-REQUISITE FOR COURSE.

COURSE III - NUTRIENT SERIES

THIS COURSE IS DESIGNED FOR THE TREATMENT PLANT OPERATOR OR TECHNICIAN WHO IS REQUIRED TO MONITOR EFFLUENT DISCHARGES UNDER A NATIONAL POLLUTANT DISCHARGE ELIMINATION SYSTEM (NPDES) PERMIT AND WHO HAS HAD LITTLE EXPERIENCE IN WASTEWATER ANALYSES.

THE COURSE INCLUDES THE FOLLOWING PARAMETERS: ORGANIC NITROGEN, AMMONIA NITROGEN, NITRATE NITROGEN, NITRITE NITROGEN, TOTAL PHOSPHORUS, CHEMICAL OXYGEN DEMAND AND OIL/GREASE. AT THE CONCLUSION OF THIS TRAINING, THE STUDENT WILL BE FAMILIAR WITH THE STANDARD TEST PROCEDURE FOR EACH PARAMETER AND WILL HAVE PERFORMED EACH ANALYSIS.

PRE-REQUISITES

PARTICIPANT SHOULD HAVE COMPLETED COURSE I - BASIC LABORATORY SKILLS OR HAVE THE EQUIVALENT EXPERIENCE. SATISFACTORY COMPLETION OF COURSE II - BASIC PARAMETERS FOR MUNICIPAL EFFLUENTS IS ADVISABLE BUT NOT REQURIED.

COURSE IV - METALS ANALYSES

THIS COURSE IS DESIGNED FOR THE TREATMENT PLANT OPERATOR OR TECHNICIAN WHO IS REQUIRED TO MONITOR EFFLUENT DISCHARGES UNDER A NATIONAL POLLUTANT DISCHARGE ELIMINATION SYSTEM (NPDES) PERMIT AND WHO HAS LITTLE OR NO EXPERIENCE WITH ATOMIC ABSORPTION, FLAME EMISSION OR VOLUMETRIC METHODS OF METALS ANALYSIS.

THE FOLLOWING METALS WILL BE DETERMINED BY ATOMIC ABSORPTION METHODS: LEAD, MERCURY, COPPER, MAGNESIUM, MANGANESE AND ZINC. FLAME EMISSION WILL BE UTILIZED IN THE DETERMINATION OF POTASSIUM AND SODIUM. VOLUMETRIC ANALYSIS WILL BE PERFORMED ON CALCIUM. THE COURSE WILL ALSO INCLUDE A SESSION ON INSTRUMENTAL TROUBLE-SHOOTING AND MAINTENANCE.

PRE-REQUISITES

PARTICIPANT SHOULD HAVE COMPLETED COURSE I - BASIC LABORATORY SKILLS OR HAVE THE EQUIVALENT EXPERIENCE. SATISFACTORY COMPLETION OF COURSE II AND III IS ADVISABLE BUT NOT REQUIRED.

PLEASE COMPLETE THE ATTACHED FORM AND RETURN AS SOON AS POSSIBLE, SINCE THE SIZE OF THE CLASS WILL BE LIMITED.

THERE WILL BE NO COST TO THE STUDENT OR THE EMPLOYER FOR THESE COURSES. THE DEADLINE FOR RECEIPT OF THE ENCLOSED APPLICATION FORM IS TWO WEEKS PRIOR TO THE COURSE THAT THE TRAINEE IS APPLYING FOR.

TRAINEE APPLICATION FORM

COURSE TITLE ______________________________

COURSE DATE ______________________________

APPLICANT'S NAME ______________________________

MAILING ADDRESS ______________________________

CITY & STATE ______________________________

EMPLOYER ______________________________

TELEPHONE NO. EMPLOYER ______________________________

TELEPHONE NO. RESIDENCE ______________________________

OPERATOR CERTIFICATION HELD ______________________________

YEARS EMPLOYED IN FIELD ______________________________

LAST YEAR OF SCHOOL COMPLETED ______________________________

DESCRIPTION OF YOUR PLANT PROCESS ______________________________

____

____

DESCRIBE YOUR LABORATORY EXPERIENCE ______________________________

____

____

DESCRIBE YOUR DUTIES ______________________________

____

PARAMETERS REQUIRED OF YOUR PLANT (SEE YOUR PERMIT) ______________________________

____

____

NOTICE: THIS APPLICATION MUST BE FILLED OUT PERSONALLY BY THE APPLICANT IN HIS OWN HANDWRITING.

MAIL TO: WILLIAM T. ENGEL, COURSE COORDINATOR
POLLUTION ABATEMENT TECHNOLOGY DEPARTMENT
CHARLES COUNTY COMMUNITY COLLEGE
P.O. BOX 910
LA PLATA, MD 20646

(SAMPLE STUDENT SKILLS CHECKLIST)

Name ______________________________

Employer ______________________________

To assist us in processing applications, please check YES or NO for each of the following items:

	YES	NO
I have operated a laboratory gas burner	___	___
I have operated a laboratory hotplate/stirrer	___	___
I have operated an autoclave	___	___
I have operated a laboratory drying oven	___	___
I have used a vacuum source to filter liquids	___	___
I have used a desiccator	___	___
I have weighed items on an analytical balance	___	___
I have weighed items on a single pan balance	___	___
I have used a graduate to measure liquids	___	___
I have used a volumetric pipet to measure liquids	___	___
I have used a graduated (Mohr) pipet to measure liquids	___	___
I have used a pipet bulb to fill a pipet	___	___
I have used a volumetric flask to prepare solutions	___	___
I have used chromic acid to clean glassware	___	___
I have operated a laboratory safety shower	___	___
I have operated a laboratory eye washer	___	___
I have operated a fume hood	___	___
I have prepared 0.0375N potassium biiodate solution	___	___
I have made out labels for bottles of reagents	___	___
I have recorded a reading at a meniscus	___	___
I have titrated one solution against another to a color change end point	___	___
I have calculated the normality (N) of a solution	___	___
I have recorded laboratory data in a laboratory notebook	___	___
I have entered laboratory data on a pre-printed form	___	___
I have recorded information about samples on record sheets	___	___
I have located required purchase information in a catalog of laboratory equipment	___	___
I have written a purchase order for chemicals	___	___
Volume means space occupied by a solid, liquid, or gas	___	___
mg/l means milligrams per liter	___	___
1 kilogram equals 0.001 gram	___	___

(SAMPLE STUDENT SKILLS CHECKLIST)

Name ______________________________

Employer ______________________________

To assist us in processing applications, please check YES or NO for each of the following items:

	YES	NO
1 inch equals 2.54 cm	___	___
1000 ml equals 1 liter	___	___
85 times 4.1 equals 42.5	___	___
7 minus 2 divided by 0.02 equals 250	___	___
3.26 rounded to the nearest tenth is 32.6	___	___
84.55147 rounded to the nearest thousandth is 84.551	___	___

(SAMPLE LETTER OF ACCEPTANCE FOR TRAINING)

(Institutional Letterhead)

(Date)

To

Dear (Name):

A reservation has been confirmed for your participation in the course "Effluent Monitoring Procedures: Basic Laboratory Skills," to be conducted at (address, including building and room identification if pertinent).

Formal class activities will begin promptly at 8:30 AM on Monday, (date) and the course will be completed by 12:30 PM on Friday, (date). Please arrange your travel schedule so that you will be in the classroom at the start of course activities on Monday and that you will not have to hurry your departure on Friday.

Information about local travel, transportation, and local hotels is enclosed for your assistance. We believe that you will wish to make your own hotel or motel reservations.

We look forward to seeing you at the course, and we will do everything in our power to make this course a pleasant and rewarding experience for you.

Sincerely yours,

(signature)
Course Coordinator

Note: If something develops which makes it impossible for you to attend the course, please telephone (number) or write this office immediately, in order that another applicant may be admitted to the course in your place. Please do not arrange for a substitute without first getting the approval of this office.

(SAMPLE STANDBY LETTER)

(Institutional Letterhead)

(Date)

To

Dear (Name):

We have received your application for admission to the course "Effluent Monitoring Procedures: Basic Laboratory Skills," to be conducted at (name of institution) during the period (date to date).

We would be most pleased to enroll you in this course, but by the time we received your application, all available positions in the class had been reserved. As you may know, we limit the class size to a fixed number in order to provide for the greatest possible amount of personal instruction during the course, and to provide each participant with the greatest possible opportunity for actual practice in the laboratory.

We have made a tentative reservation for you in the next offering of the course, which is scheduled to be given (dates). If this will be satisfactory to you, please write or call us within (number) days, so that we can confirm your reservation.

In the meantime, we have placed your name on the waiting list for the course dates which you requested. If a vacancy does become available, we will let you know immediately.

Sincerely yours,

(signature)
Course Coordinator

(SAMPLE LETTER OF REFERRAL)

(Institutional Letterhead)

(Date)

To

Dear (Name)

We have received your application for admission to the course "Effluent Monitoring Procedures: Basic Laboratory Skills," to be conducted at (name of institution) during the period (date to date).

Based on our review of your previous laboratory experience, we consider that it would be very doubtful whether this course would provide you with all the knowledge and skills you will require to perform the self-monitoring tests and measurements on your municipal wastewater effluents.

Accordingly, we are confirming your reservation in this course, subject to your first satisfactorily completing the course (title of "Basic Skills" course). This course will be conducted at (location) (dates). We have made a tentative reservation for you to attend this course. Please let us know if you can attend this offering of the course.

If you must delay taking the course (name of "Basic Skills" course) at this time, then it will be necessary to delay your acceptance in the course which you have requested.

In the course (name of "Basic Skills" course) you will learn many things not covered in the later course, including use of the analytical balance, preparation and standardization of laboratory reagents, care and maintenance of laboratory supplies and equipment, and related tasks.

We are most anxious to help you learn to perform all the tasks required for self-monitoring of your municipal wastewater effluents. Please let us know if you can come to both courses.

Sincerely yours,

(signature)
Course Coordinator

(SAMPLE LETTER OF WELCOME)

(Institutional Letterhead)

(Date)

TO: COURSE PARTICIPANTS --

We are looking forward to your participation in the course "Effluent Monitoring Procedures: Basic Laboratory Skills," scheduled for presentation at this Center during the period (date to date). If you find you cannot attend the course, please call us (telephone number).

To assist your planning and preparation for this course, the following items are enclosed:

1. List of hotels and motels
2. Information on local bus transportation and city map, (NOTE: If bus service is used to the Center, you must have exact fare of (amount) on boarding bus).

On your arrival in the classroom you will be provided a course manual and related materials. Production schedules make it impossible to mail manuals to you in advance of course date.

The course will start at 8:30 AM on Monday, (date) in (room identification) and will close no later than 12:30 PM, Friday, (date). At the conclusion of the course, a certificate will be awarded verifying which analytical measurements you have performed in a satisfactory manner. Please arrange your travel schedule after closing exercises. (Approximately (number) hours should be allowed for travel from (name of institution) to the airport.)

This course involves a considerable amount of work in the laboratory, using concentrated acids and bases. You will want to bring appropriate clothing.

(Name), of our staff, is serving as Course Coordinator and will be available to assist you in solving any special problems you encounter while attending the course.

Should you have questions or desire assistance in any way, please do not hesitate to contact us.

Sincerely yours,

(signature)
Director
Institution Name

(SAMPLE REGISTRATION SUMMARY)

____

(Course Title)

____

(Date)

REGISTRATION

INDIVIDUAL	WORD REC'D.	APPL. REC'D.	ACCEPT. SENT	COURSE INFO. SENT

(SAMPLE WAITING LIST SUMMARY)

WAITING LIST

INDIVIDUAL	WORD REC'D.	APPL. REC'D.	ACTION TAKEN

(SAMPLE NON-ATTENDANCE SUMMARY)

____

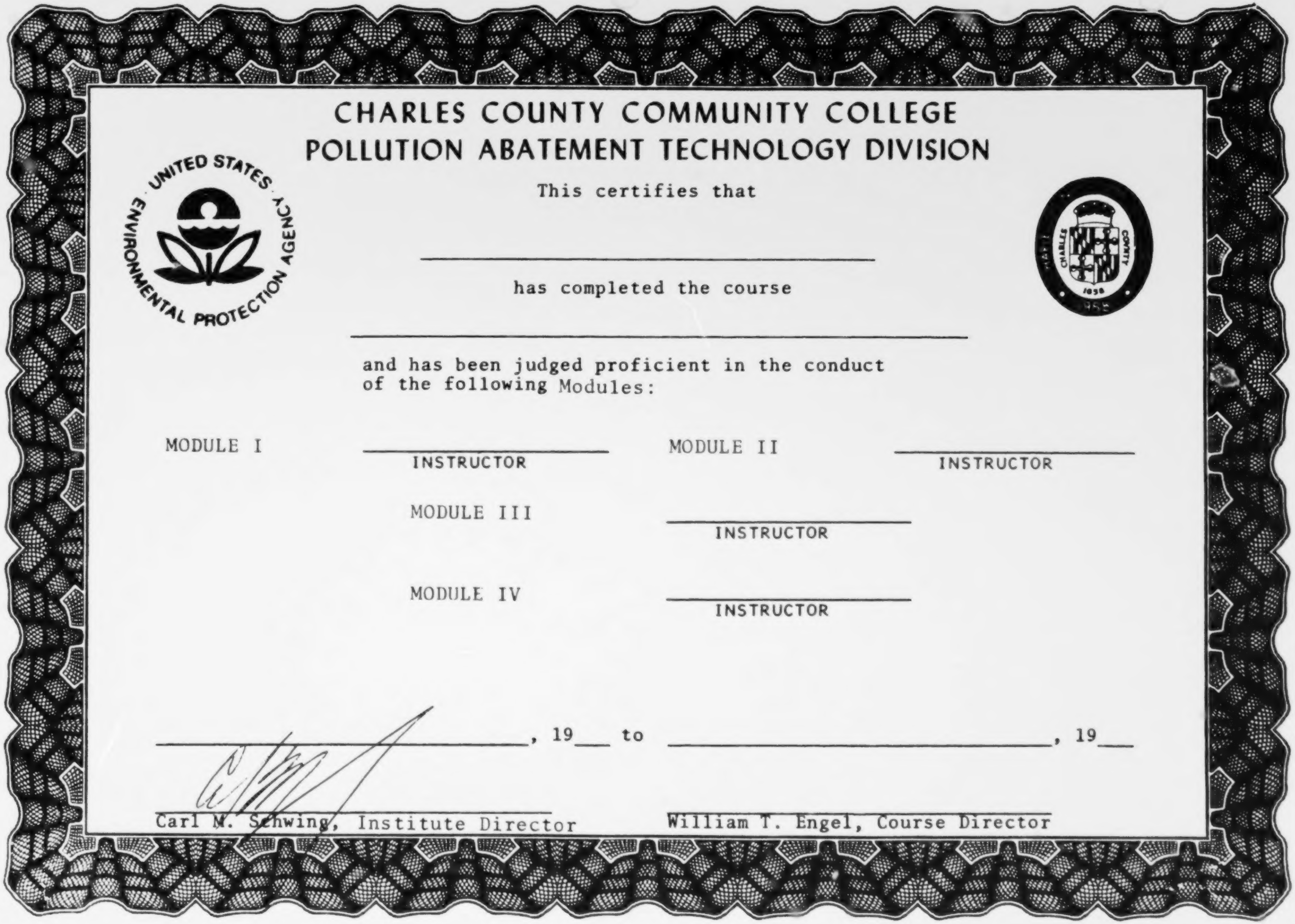
(Course Title)

____

(Date)

Not Admitted Lack of Space	No Shows

EXAMPLE CERTIFICATE



CHARLES COUNTY COMMUNITY COLLEGE
POLLUTION ABATEMENT TECHNOLOGY DIVISION

This certifies that

____

has completed the course

____

and has been judged proficient in the conduct
of the following Modules:

MODULE I __________________ INSTRUCTOR
MODULE II __________________ INSTRUCTOR
MODULE III __________________ INSTRUCTOR
MODULE IV __________________ INSTRUCTOR

____________________, 19__ to ____________________, 19__

Carl M. Schwing, Institute Director

William T. Engel, Course Director

3. Printed and Reproduced Materials - Summary

a. General Information

In addition to the student reference text, standardized letters and administrative forms/materials, presentation of this course also requires calculation forms, laboratory data sheets, and graph forms which must be prepared in quantity by the Course Secretary.

1) In the following summarizing table, all of the standardized materials noted above are identified and supported with additional information on due date, the number to be prepared (for a class of 18 students), and the ultimate fate of the materials in permanent course records. Institutions offering this course may find it necessary to add to or to modify these standardized materials. It is suggested that plans to do so be noted on the summarizing table, with samples or examples provided on separate pages.

2) A sample or example of each item listed (except the student reference text) is shown following the summarizing table.

a) Samples can be copied directly if they meet requirements of the training institution.

b) The examples are shown in recognition that a corresponding item probably will be needed by the training institution but probably will have to be modified to fit the situation.

b. Responsibilities for Printed and Reproduced Material

1) Course Coordinator

a) Reviews the administrative materials for conformance to the requirements of the regulatory authority;

b) Makes modifications as necessary to the samples and examples provided in this Guide;

c) Decides upon and designs any additional administrative documents or records needed; and

d) Provides the Course Secretary with complete identification of material to be copied directly or to be modified and also provides samples of any new material required for course administration.

2) Instructors

a) Review all materials identified for the procedures for which they have instructional responsibility;

b) Design new supportive instructional material as required; and

c) Provide the Course Secretary with complete information on material to be copied directly or to be modified and also provide samples of any new material required for student instruction.

3) Course Secretary

a) Receives identification of existing materials and samples of modified and new material from Course Coordinator and Instructors.

b) Adds to the summarizing table, in the appropriate locations, the identifying information, together with the supporting information on due date, quantity, confidentiality, and ultimate fate of any new or revised material designed by Course Coordinator or by Instructors;

c) Reproduces, or arranges reproduction of, the needed course materials so that they will be available for use at the time and place required.

c. Special Warnings

1) All staff members should be particularly alert to adjustments in "Due Date" which must be made when the course is conducted in the field, if training equipment and supplies must be shipped to the course site.

2) Preparation of these training materials is a potential source for great difficulty in course development and presentation. Few activities in course planning and development require a greater amount of effective teamwork among all staff members. The greatest problem here is one of timing.

a) All staff members must provide necessary information and samples of new or modified materials with adequate lead time to meet "Due Dates." The amount of lead time is not specified here; this will vary from one institution to another.

b) The Course Secretary must be diligent in advising Course Coordinator and Instructors of impending logistic problems if delays occur in submission of materials, and must give prompt attention to printing or reproduction of needed materials when delivered by staff members.

c) The author of this guide ruefully confesses that the worst and most frequent breakdowns in this area usually are the result of belated delivery of needed material from Instructional Staff to the Course Secretary.

SUMMARY OF REQUIRED PRINTED/REPRODUCED MATERIAL

Description	Lesson	When Needed	Number to be Prepared	Confidential ?	Permanent Record?	Remarks
Administrative						
Course Announcement	-	6 months before course	Indeterminate	No	1 copy	Distribute to target group 6 months before course.
Course Description	-	6 months before course	Indeterminate	No	1 copy	Same as announcement. Can be used in conjunction with chronological course listings.
Application for Admission	-	6 months before course		No	No	Usually part of course announcement. May be separate sheet.
Prerequisite Verification	-	6 months before course	Indeterminate	No	1 copy	Attached to application form
Standard Letter: Acceptance	-	5 months before course	100	No	No	Copies will show up in student files.
Standard Letter: Standby: Full Class - Waiting List	-	5 months before course	100	No	No	Copies will show up in student files.
Standard Letter: Referral to Basic Lab Skills Course	-	5 months before course	100	No	No	Copies will show up in student files.
Standard Letter: Welcome and Local Information: Hotels/Motels, Transportation Schedule, Schematic Area Map Classroom Location	-	30 days before course	100	No	1 copy	In course file folder.
Registration Summary Record	-	5 months before course	1	No	Yes	In Registrar's three-ring notebook.

SUMMARY OF REQUIRED PRINTED/REPRODUCED MATERIAL

Description	Lesson	When Needed	Number to be Prepared	Confidential ?	Permanent Record?	Remarks
Administrative (Cont'd.)						
Waiting List Summary	-	90 days before course	1	No	Yes	In Registrar's three-ring notebook.
Non-Attendance Summary	-	First day of course	1	No	Yes	In Registrar's three-ring notebook.
Trainee Registration Card	-	First day of course	15	No	Yes	Institution's Records.
Registration Tally and Class Roster	-	First day of course	As Required	No	Yes	In course file folder.
Course Certificates	-	Final day of course	15	No	Yes	In student file.
Student Performance Summary Record	-	Final day of course	15	Yes	Yes	In Registrar's three-ring notebook.
Classroom/Laboratory Basic Mathematics						
Pre & Post Tests	1 of 4	Day 1	15	No	Yes	Duplicate completed, corrected sheet and keep in students' files.
Summary of Student Performance	-	Final day of	15	No	Yes	Keep in students' files.

SUMMARY OF REQUIRED PRINTED/REPRODUCED MATERIAL

Description	Lesson	When Needed	Number to be Prepared	Confidential ?	Permanent Record?	Remarks
Administrative (Cont'd.)						
Chemical Laboratory						
Student Performance Check List	2 of 4	Day 1	15	No	Yes	Keep in students' files.
Microbiology						
Check List	3 of 4	Day 1	15	No	Yes	Keep in students' files.
Laboratory Inventory						
Student Performance	-	Day 1	15	No	Yes	Keep in students' files.

BASIC MATHEMATICS

PRE - TEST

1. Given the following table, list one Metric and one English unit for the listed measurements:

	METRIC	ENGLISH
Weight	______	______
Length	______	______
Volume	______	______
Temperature	______	______

2. State the numerical value for the following metric prefixes:

Kilo	______
Centi	______
Milli	______

---

3. Add: $\begin{array}{r}156\\ \underline{+\ 24}\end{array}$ $\qquad$ $\begin{array}{r}79\\ \underline{+62}\end{array}$

4. Subtract: $\begin{array}{r}50\\ \underline{-12}\end{array}$ $\qquad$ $\begin{array}{r}262\\ \underline{-79}\end{array}$

5. Multiply:

$205 \times 82 =$

$98 \times 17 =$

$642 \times 8 \times 3 =$

$(24)\ (7) =$

6. Divide:

13,888/124

966/23

---

7. Round the following to the nearest ten:

(a) 47
(b) 912

8. Round the following to the nearest hundred:

(a) 847
(b) 75,619

---

9. Add:

0.[illegible]
4.[illegible]
24
+ 1.04

59.6
+ 0.37

10. Subtract:

12.6
- 0.8

27.3
- 4.9

11. Multiply:

2.35 x 0.05 =

(45.38) (1,000) =

12. Divide:

25.8/3.9

615.6/1.5

---

13. Round off to the nearest tenth:

(a) 8.9074
(b) 3.26

14. Round off to the nearest thousandth:

(a) 94.66241
(b) 0.5358

---

15. Given A = (B - C)/D. Find A when B = 24.6239
C = 24.5197
D = 10

16. Given A = B x C/D. Find A when B = 6.4
C = 7.9
D = 3.2

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17. Express the following as percentages:

(a) 0.05
(b) 0.79

18. Calculate the following and express answers as percentages:

(a) $\frac{300 - 24}{300} =$

(b) $\frac{220 - 19}{220} =$

MODULE I - QUIZZES

QUIZ I

METRIC SYSTEM

Name ____________________________

1. Given the following table, list one Metric and one English unit for the listed Measurements:

	METRIC	ENGLISH
Weight	______	_______
Length	______	_______
Volume	______	_______
Temperature	______	_______

2. State the numerical value for the following Metric prefixes:

kilo ______

Centi ______

Milli ______

QUIZ II

WHOLE NUMBERS

Name ______________________

1. Perform the indicated operations:

$$\begin{array}{rcrcrcr} 156 \text{ gms} & \quad & 79 \text{ gms} & \quad & 50 \text{ ml} & \quad & 262 \text{ gms} \\ +\,\underline{\ 24}\text{ gms} & & \underline{+62}\text{ gms} & & -\underline{12}\text{ ml} & & \underline{-79}\text{ gms} \end{array}$$

$642 \times 8 \times 3 =$

$(24)\ (7) =$

$224/2 =$

$1368/3 =$

2. Round the following to the nearest ten:
   - (a) 47
   - (b) 912

3. Round the following to the nearest hundred:
   - (a) 847
   - (b) 75,619

QUIZ III

DECIMALS

Name ______________________

1. Round off to the nearest tenth:

   (a) 8.9074

   (b) 3.26

2. Round off to the nearest thousandth:

   (a) 94.66241

   (b) 0.5358

3.

$$\begin{array}{l} \ \ 0.269 \\ \ \ 4.2 \\ \ 24 \\ +\ 1.04 \\ \hline \end{array}$$

4. 0.05 x 2.35 =

5. (45.38) (1,000)

6. 25.8/3.9 =

7. 12.6 - 0.8 =

8. 27.3 - 4.9 =

QUIZ IV

FORMULAS

Name ____________________________

1. Given $A = \frac{(B-C)\ (1,000)}{D}$ Find A when $B = 24.6239$ g
$C = 24.6197$ g
$D = 50$ ml

2. Given $A = B \times C/D$. Find A when $B = 20.0$ ml
$C = 0.0375$ N
$D = 15.0$ ml

QUIZ V

PERCENTAGES

Name ____________________

1. Express the following as percentages:

   (a) 0.05

   (b) 0.79

2. Calculate the following:

   (a) $\frac{300 - 24}{300} =$

   (b) $\frac{220 - 19}{220} =$

Express answers as percentages:

EFFLUENT MONITORING PROCEDURES

BASIC LABORATORY SKILLS

Checklist of Student Performance

Student Name ______________________________ Date ______________

A. Safety

1. Located the following in the laboratory:

    a. Safety Shower

    b. Fire Extinguisher

    c. Fire Blanket

    d. Eye Wash

    e. First Aid Kit

    f. Fume Hood

    Yes _____ No _____

2. Given three emergency situations, responded properly to all.

    Yes _____ No _____

B. Bench Sheets/Notebooks

1. Completed a sample bench sheet. Yes _____ No _____

C. Labeling

1. Prepared a label for a chemical stock bottle. Yes _____ No _____

D. Names and Formulas of Compounds

1. Completed the four checklists. Yes _____ No _____

2. Using the four consumable supply lists, selected reagents with 100% accuracy. Yes _____ No _____

E. Care and Use of Equipment

1. Accurately identified and used the following:

    a. Buret Yes _____ No _____

    b. Mohr Pipet Yes _____ No _____

c. Volumetric Pipet Yes _____ No _____

d. Volumetric Flask Yes _____ No _____

2. Accurately identified and used the common laboratory glassware: Yes _____ No _____

3. Accurately identified and used the common laboratory equipment: Yes _____ No _____

4. Cleaned Volumetric Glassware with Chromic Acid Cleaning Solution: Yes _____ No _____

F. Matter

1. Completed the student demonstrations: Yes _____ No _____

2. Recorded results in the laboratory notebook: Yes _____ No _____

G. Solutions

1. Calculated various concentrations of solutions: Yes _____ No _____

H. Balances

1. Accurately operated the following:

a. Double-pan analytical balance: Yes _____ No _____

b. Single-pan analytical balance: Yes _____ No _____

c. Triple-beam balance: Yes _____ No _____

d. Top-loading electric balance: Yes _____ No _____

2. Determined the weight of an unknown Gooch crucible to ± 0.0005 g, using the double-pan analytical and single-pan analytical balance: Yes _____ No _____

MODULE III - MICROBIOLOGY

EVALUATION

NAME ______________________________

COMPLETE THE FOLLOWING STATEMENTS:

1. Microbiology is the study of ______________________________

2. The term "pathogenic" refers ______________________________ to organisms.

3. Bacteria are ______________________________
____

4. The coliform organisms are used to ______________________________
____

5. Disinfection is ______________________________
____

6. Sterilization is ______________________________
____

7. Two physical agents of disinfection are ______________________________
and ______________________________

8. Two chemical agents of disinfection are ______________________________
and ______________________________

9. The maintenance of ______________________________
conditions is of major importance when performing microbiological analysis.

10. Use of the ______________________________
and ______________________________ will help maintain aseptic conditions in the laboratory.

PART II - INSTRUCTIONAL PACKAGE WORKSHEETS

For each Lesson (commonly termed "EMP" by Instructors) in the Student Reference Manual, there is an Instructional Package Worksheet (IPW) in this Guide. The Worksheet is for guidance to the Instructor for development of the subject matter covered in the course.

The course will include a review of basic mathematics. Applications in the chemical laboratory such as weighing techniques, use of equipment, and solution preparation will be stressed. An introduction to basic microbiological techniques is also included.

These Worksheets are not scripts. The Instructor will need to make extensive and detailed preparation in order to perform the assigned tasks effectively and efficiently. The Instructional Packages do provide a perspective on the background of each analytical procedure, lesson-by-lesson learning achievement levels the students should attain, and indication of available audiovisual and other instructional resources, and a recommended course of action in pre-course preparation and classroom/laboratory instruction.

Application of these Instructional Packages will help the Instructor to reduce the time required for planning and organizing a strategy of preparation and instruction. But time and effort are required for physical preparations for classroom and laboratory instruction; time and effort are required for rehearsals of Instructor performance in classroom and laboratory. These requirements never can be met by such a Course Guide as this; ultimately the Instructor is the key person in assuring that the student acquires the needed knowledge and skills.

GUIDELINES FOR
INSTRUCTIONAL PACKAGE WORKSHEET

SUBJECT MATTER: Basic Mathematics

UNIT OF INSTRUCTION: Summary of Instruction on Mathematics

LESSON NUMBER: Total 5

ESTIMATED TIME: 3 Hours

JUSTIFICATION: NPDES Report Form requires mathematical calculations.

ENTRY LEVEL BEHAVIOR: Student must have completed registration form.

A. INSTRUCTIONAL OBJECTIVE

1. Terminal Behavior - The student will satisfactorily complete the five units of instruction on Basic Mathematics.

2. Conditions - Oral and written presentation with use of handouts.

3. Accepted Performance - 90% of the tested material, 100% correct.

B. INSTRUCTIONAL RESOURCES

1. Available Media

    Self-Monitoring Procedures: Basic Laboratory Skills, CCCC
    Metric Conversion Table, GPO
    Mathematics, A Basic Course, Dever & Salten, CAM
    Basic Mathematics Vol. I-V, Daniel Borrow, EBEC
    A Guide to Remedial Instruction in Basic Mathematics, Gay, Count, Ponder, GREEN
    Metric System of Linear Measure (821), CSC
    Elementary Mathematics and Basic Calculations, Eglof & Swope, WSW
    Modu-math Video Cassette Math Course, SUNY
    See Part A, pages 9-3 and 9-4 for code explanations

2. Suggested Media - Wall Chart on the Metric System

C. INSTRUCTIONAL APPROACH (Sequencing)

1. Preparation for Instruction - Insure that all available media are present in the classroom at the time of instruction.
    a. Lesson I, Metric System - 30 minutes
    b. Lesson II, Whole Numbers - 30 minutes
    c. Lesson III, Decimals - 30 minutes
    d. Lesson IV, Formulas - 30 minutes
    e. Lesson V, Percentages - 30 minutes

A pretest (Part A, pages 12-6 and 12-7) covering the above lessons will be given at the beginning of this unit. If the student satisfactorily completes this test, he will be allowed to omit these lessons.

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D. IPW EQUIPMENT AND SUPPLY REQUIREMENTS

Metric Conversion Table (one per student)

Wall Chart of the Metric System

E. IPW REAGENT REQUIREMENTS

None

GUIDELINES FOR
INSTRUCTIONAL PACKAGE WORKSHEET

SUBJECT MATTER: Basic Mathematics

UNIT OF INSTRUCTION: Metric System

LESSON NUMBER: 1 of 5

ESTIMATED TIME: 30 Minutes

JUSTIFICATION: The results of the following analyses are always expressed in units of the metric system: Suspended Solids, Dissolved Oxygen, Biochemical Oxygen Demand, and Chlorine Residual.

ENTRY LEVEL BEHAVIOR: Student must have completed registration form.

A. INSTRUCTIONAL OBJECTIVE
   1. Terminal Behavior - The student will:
      a. Name the metric and English terms for:
         1) mass
         2) volume
         3) temperature
      b. State the numerical value for the following metric prefixes:
         1) kilo
         2) milli
   2. Conditions - Written or oral presentation from recall.
   3. Accepted Performance - 80% of the tested material, 100% correct.

B. INSTRUCTIONAL RESOURCES
   1. Available Media

      Metric Conversion Table, GPO
      Metric System of Linear Measure (821), CSC
      Effluent Monitoring Procedures: Basic Laboratory Skills, CCCC

   2. Suggested Media - None

C. INSTRUCTIONAL APPROACH (Sequencing)
   1. Presentation
      a. Develop the idea that the metric system is a measurement system based on the number 10. Also include where the metric system is used and the gradual conversion of the United States (English System) to the Metric System.

b. Illustrate the relationships between the Metric and English Systems.

Measurement e.g.	Metric	English
Mass or weight	milligrams, grams, kilograms	Ounces, pounds, tons
Length	centimeter, millimeter, meter, kilometer	inches, feet, yard, mile
Volume	milliliter, liter	pints, quarts, gallons
Temperature	Centigrade (^{o}C)	Fahrenheit (^{o}F)

c. Emphasize that numerical conversions are not necessary for this laboratory work. If they need to be done, use the conversion card. To illustrate this, conversion cards may be handed out at this time. Show the numerical relationships between the two systems using temperature as an example.

Examples of common approximate numerical conversions as follows:

1 pound (lb) = 453 gram (g)
1 inch (in) = 2.54 centimeter (cm)
1 quart (qt) = 1 liter (1)

d. Illustrate the following relationships of the numerical value for the metric prefixes.

Kilo = 1000
Centi = 1/100 or 0.01
Milli = 1/1000 or 0.001

Examples are:

1000 meters = kilometer
1000 milligrams = 1 gram
1000 ml = 1 liter
1000 mm = 1 meter

e. Give Quiz I (Part I, page 12-8). If student does not meet accepted performance, supplementary work from a specific reference will be given.

2. Student Performance and Evaluation

   a. Work examples given and discuss any problems.

   b. Complete Quiz I at end of lecture (Part I, page 12-8).

D. EQUIPMENT AND SUPPLY REQUIREMENTS - None

E. REAGENT REQUIREMENTS - None

GUIDELINES FOR
INSTRUCTIONAL PACKAGE WORKSHEET

SUBJECT MATTER: Basic Mathematics

UNIT OF INSTRUCTION: Whole Numbers

LESSON NUMBER: 2 of 5

ESTIMATED TIME: 30 Minutes

JUSTIFICATION: Mathematical operations involving whole numbers are used in the gravimetric and volumetric analyses involved in the five basic parameters.

ENTRY LEVEL BEHAVIOR: Completion of Lesson 1 of Module I.

A. INSTRUCTIONAL OBJECTIVE

1. Terminal Behavior - Using whole numbers, the student will add, subtract, multiply and divide, including the following operations:

   a. Rounding off to the nearest specific value (tens, hundreds and thousands).

   b. Using only 2 numbers (e.g.)

      $$\begin{array}{r} 221\ \text{g} \\ \underline{+72}\ \text{g} \end{array} \qquad \begin{array}{r} 143\ \text{ml} \\ \underline{-28}\ \text{ml} \end{array}$$

      (82) (205) or 82 x 205

      221/16

   c. Using 3 numbers (multiplication only)

      (82) (12) (16) or 82 x 12 x 16

2. Conditions - Written and/or oral presentation from recall.

3. Accepted Performance - 90% of tested material, 100% correct.

B. INSTRUCTIONAL RESOURCES

1. Available Media

   Mathematics, A Basic Course, Dever & Salten, CAM
   Basic Mathematics Vol. I-V, Daniel Borrow, EBEC
   A Guide to Remedial Instruction in Basic Mathematics, Gay, Count, Ponder, GREEN
   Elementary Mathematics and Basic Calculations, Eglof & Swope, WSW
   Effluent Monitoring Procedures: Basic Laboratory Skills, CCCC
   Modu-Math Video Cassette Math Course, SUNY

2. Suggested Media - None

C. INSTRUCTIONAL APPROACH (Sequencing)

1. Presentation

a. Demonstrate the basic mathematical operations. It is recommended that additional examples be shown. These may be done either with a worksheet or at the blackboard.

e.g.

Addition:

$$\begin{array}{r} 42 \text{ g} \\ +\underline{6} \text{ g} \\ 48 \text{ g} \end{array}$$

Subtraction:

$$\begin{array}{r} 50 \text{ ml} \\ -\underline{12} \text{ ml} \\ 38 \text{ ml} \end{array}$$

Multiplication:

62 ml x 10 = 620 ml

Division:

200g/40 means

$$\begin{array}{r} 5 \\ 40\overline{)200} \end{array} \quad \text{or } \underline{5} \text{ g.}$$

b. Demonstrate the process of rounding off whole numbers using examples of balance accuracy and buret accuracy.

(1) Explain the decimal system of numbers to include the value of each position through millions.

(2) Give the following rules with examples:

RULES FOR ROUNDING OFF NUMBERS:

(a) When the first digit after those being retained is less than 5, all digits retained remain the same.

EXAMPLE:

Round 912 to the nearest ten:

Answer 910

(b) When the first digit after those being retained is larger than 5, the last digit is rounded off by increasing it one number.

EXAMPLE:

Round 47 to the nearest ten:

Answer 50

(c) When the first digit after those being retained is rounded off by increasing it one number.

EXAMPLE:

Round 65 to the nearest ten.

Answer: 70

Round 75 to the nearest ten.

Answer: 80

Give additional examples such as:

Round the following numbers to the nearest hundred.

847 ------→ 800

75,619 ------→ 75,600

Round the following numbers to the nearest thousand.

16,945 ------→ 17,000

843,228 ------→ 843,000

Numbers with units may be used in this exercise.

c. Give Quiz II (Part I, Page 12-9). If the student does not meet the accepted performance, supplementary work from a specific reference (see Available Media) should be given.

2. Student Performance and Evaluation
   a. Work examples given and discuss any problems.
   b. Complete Quiz II at end of lecture.

D. EQUIPMENT AND SUPPLY REQUIREMENTS - None

E. REAGENT REQUIREMENTS - None

GUIDELINES FOR INSTRUCTIONAL PACKAGE WORKSHEET

SUBJECT MATTER: Basic Mathematics

UNIT OF INSTRUCTION: Decimals

LESSON NUMBER: 3 of 5

ESTIMATED TIME: 30 Minutes

JUSTIFICATION: Mathematical operations involving decimals are used in the gravimetric and volumetric analyses involved in the five basic parameters.

ENTRY LEVEL BEHAVIOR: Completion of Lesson 1 of Module I.

A. INSTRUCTIONAL OBJECTIVE

1. Terminal Behavior - The student will:
   - a. Differentiate between decimals and whole numbers.
   - b. Write a specified decimal number.
   - c. Add, subtract, multiply and divide decimal numbers, e.g.,

     Only two numbers:

addition	4.793 + 0.921
subtraction	4.793 - 3.921
multiplication	(1.21) (0.92) or 1.21 x 0.92
division	1.73/2.1

   - d. Round off to the nearest specified value, e.g.,

     4.670 to the nearest tenth
     0.2598 to the nearest hundredth
     26.0403 to the nearest thousandth

2. Conditions - Written/or oral presentation from recall.

3. Accepted Performance - 90% of the tested material, 100% correct.

B. INSTRUCTIONAL RESOURCES

1. Available Media

   Mathematics, A Basic Course, Dever & Salten, CAM
   Basic Mathematics Vol. I-V, Daniel Borrow, EBEC
   A Guide to Remedial Instruction in Basic Mathematics, Gay, Count, Ponder, GREEN
   Elementary Mathematics and Basic Calculations, Eglof & Swope, WSW
   Effluent Monitoring Procedures: Basic Laboratory Skills, CCCC
   Modu-Math Video Cassette Math Course, SUNY

2. Suggested Media - None

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C. INSTRUCTIONAL APPROACH (Sequencing)

1. Presentation

   a. Illustrate tenths, hundredths, thousandths, and ten thousandths in the following number.

      2 4 . 9 4 7 2
      tenths
      hundredth
      thousandths
      ten thousandths

   b. Given a list of decimals and whole numbers, differentiate between them.

   c. Write orally specified decimal numbers.

   d. Apply the basic mathematical operations covered in lesson 2 to decimals. Again, it is recommended that additional examples be shown either with a worksheet or at the blackboard.

      Addition:

$$\begin{array}{rl} & 4.6701 \text{ g} \\ + & \underline{0.743\ \ } \text{ g} \\ & 5.4131 \text{ g} \end{array}$$

      Subtraction

$$\begin{array}{rl} & 48.5 \text{ ml} \\ - & \underline{19.7} \text{ ml} \\ & 28.8 \text{ ml} \end{array}$$

      Multiplication: 24.62 g x 100 = 2462 g

      Division: 36.85 g / 8.9 = 4.14 g

   e. Apply the rules of rounding off whole numbers to decimals.

      Illustrate the rules of lesson 2 by using the following examples:

      Round off to the nearest tenth:

      4.1073 ------→ 4.1
      8.47 ------→ 8.5

      Round off to the nearest thousandth:

      80.5123 -----→ 80.512
      0.00754 ----→ 0.008

   f. Give Quiz III (Part I, page 12-10). If the student does not meet the standard performance, supplementary work from a specific reference should be given (see Available Media).

2. Student Performance and Evaluation

   a. Work examples given and discuss any problems

   b. Complete Quiz III at the end of lecture (Part I , page 12-10).

D. EQUIPMENT AND SUPPLY REQUIREMENTS - None

E. REAGENT REQUIREMENTS - None

GUIDELINES FOR
INSTRUCTIONAL PACKAGE WORKSHEET

SUBJECT MATTER: Basic Mathematics

UNIT OF INSTRUCTION: Formulas

LESSON NUMBER: 4 of 5

JUSTIFICATION: Formulas are used to calculate the results of the Dissolved Oxygen, Biocnemical Oxygen Demand, and the Suspended Solids analyses.

ENTRY LEVEL BEHAVIOR: Completion of Lessons 1, 2 and 3 of Module I.

A. INSTRUCTIONAL OBJECTIVE

1. Terminal Behavior - The student will solve the following types of formulas:

   a. $A = B \times C$

   b. $A = \frac{B \times C}{D}$

   c. $A = \frac{(B-C)(1000)}{D}$

   Where A, B, C, and D may be whole numbers or decimals and B, C and/or D are data bits.

2. Conditions - From recall of oral and written presentation.

3. Accepted Performance - 80% of tested material, 100% correct.

B. INSTRUCTIONAL RESOURCES

1. Available Media

   Mathematics, A Basic Course, Dever & Salten, CAM
   Basic Mathematics Vol. I-V, Daniel Borrow, EBEC
   Elementary Mathematics and Basic Calculations, Eglof & Swope, WSW
   Effluent Monitoring Procedures: Basic Laboratory Skills, CCCC
   Modu-Math Video Cassette Math Course, SUNY

2. Suggested Media - None

C. INSTRUCTIONAL APPROACH (Sequencing)

1. Presentation

   a. Show examples of mixed operations.

   $6 \times 4/2 = \underline{12}$ $(16.4 - 3.2)/5 = \underline{2.6}$

   Additional examples of these mixed operations should be given.

b. Show the relationship of mixed operations to formula solving. Include cancellation of units.

Solids Analysis:

$$A = \frac{(B-C)(1000)}{D}$$

Where A = mg/liter suspended solids
B = Final Weight in mg
C = Initial Weight in mg
1000 = Constant (Define)
D = ml sample filtered

Sample Data

B = 24.7369 g = 24,736.9 mg
C = 24.7201 g = 24,720.1 mg
D = 50 ml

$$A = \frac{(24{,}736.9 \text{ mg} - 24{,}720.1 \text{ mg})(1000)\text{ml/liter}}{50 \text{ ml}}$$

$$A = \frac{(16.8 \text{ mg})(1000 \cancel{\text{ml}})}{50 \cancel{\text{ml}} \times \text{liter}}$$

$$A = \frac{(16.8 \text{ mg})(20)}{\text{liter}}$$

A = 336 mg/liter Concentration terms will be explained later.

Dissolved Oxygen

$$A = \frac{B \times C}{D}$$

Where A = normality of sodium thiosulfate
B = ml of bi-iodate
C = normality of bi-iodate
D = ml of sodium thiosulfate

See additional examples in student reference manual.

Instructor note: The term normality and compound names should be omitted at this time.

The symbol N, and the term ml may be used.

Sample Data

B = 20.0 ml
C = 0.0375 N
D = 18.8 ml

$$A = \frac{B \times C}{D}$$

$$= \frac{20.0\ \cancel{ml} \times 0.0375\ N}{18.8\ \cancel{ml}}$$

$$= \frac{0.75\ N}{18.8}$$

$$= \underline{0.0398\ N}$$

c. Give Quiz IV (Part I, page 12-11). If the student does not meet the accepted performance, supplementary work from a suitable reference should be given (see Available Media).

2. Student Performance and Evaluation

   a. Work examples given and discuss any problems.

   b. Complete Quiz IV at end of lecture (Part I, page 12-11).

D. EQUIPMENT AND SUPPLY REQUIREMENTS - None

E. REAGENT REQUIREMENTS - None

GUIDELINES FOR
INSTRUCTIONAL PACKAGE WORKSHEET

SUBJECT MATTER: Basic Mathematics

UNIT OF INSTRUCTION: Percentage

LESSON NUMBER: 5 of 5

ESTIMATED TIME: 30 Minutes

JUSTIFICATION: A calculation of percent removal of Biochemical Oxygen Demand and suspended solids is necessary in completion of the Discharge Monitoring Report.

ENTRY LEVEL BEHAVIOR: Completion of Lessons 1, 2, 3, and 4 of Module I.

A. INSTRUCTIONAL OBJECTIVE

1. Terminal Behavior - The student will solve the following percent removal problems to the nearest whole percent.

   a. $\% \text{ Removal BOD} = \frac{BOD_i - BOD_f}{BOD_i} \times 100$

   b. $\% \text{ Removal Suspended Solids} = \frac{S.S._i - S.S._f}{S.S._i} \times 100$

2. Conditions - From recall of oral and written presentation.

3. Accepted Performance - 80% of tested material, 100% correct.

B. INSTRUCTIONAL RESOURCES

1. Available Media

   Mathematics, A Basic Course, Dever & Salten, CAM
   Basic Mathematics Vol. I-V, Daniel Borrow, EBEC
   Elementary Mathematics and Basic Calculations, Eglof & Swope, WSW
   Effluent Monitoring Procedures: Basic Laboratory Skills, CCCC
   Modu-Math Video Cassette Math Course, SUNY

2. Suggested Media - None

C. INSTRUCTIONAL APPROACH (Sequencing)

1. Presentation

   a. Develop the concept that the phrase per hundred and percent have exactly the same meaning.

      (1) 30/100 = 30 hits per hundred times at bat or 30 percent.

      (2) 150/300 =150 bull's eyes in 300 shots or 50 bull's eyes per hundred shots or 50 percent.

   Additional examples of these relationships should be given.

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b. Show that the symbol "%" can be used instead of the word "percent."

Examples:

(1) 40 percent or 40%
(2) 65 percent or 65%

c. Show that a decimal can be converted to a percent by multiplying it by 100.

Examples:

(1) .72 x 100 = 72%
(2) .92 x 100 = 92%

d. Illustrate the use of percentages in percent removal problems.

Examples:

(1) $$\% \text{ Removal BOD} = \frac{BOD_i - BOD_f}{BOD_i} \times 100$$

Where BOD_i = 278 mg/l
BOD_f = 10 mg/l

$$\% \text{ Removal} = \frac{278 - 10}{278} \times 100$$

$$= \frac{268}{278} \times 100$$

$$= .96 \times 100 = 96\%$$

(2) $$\% \text{ Removal Suspended Solids} = \frac{S.S._i - S.S._f}{S.S._i} \times 100$$

Where $S.S._i$ = 210 mg/l
$S.S._f$ = 28 mg/l

$$\% \text{ Removal} = \frac{210 - 28}{210}$$

$$= \frac{182}{210} \times 100$$

$$= .87 \times 100 = 87\%$$

e. Give Quiz V (Part I, page 12-12). If the student does not meet the accepted performance, supplementary work from a suitable reference should be given (see Available Media).

2. Student Performance and Evaluation

   a. Work examples given and discuss any problems.
   b. Complete Quiz V at end of lecture (Part I, page 12-12).

D. EQUIPMENT AND SUPPLY REQUIREMENTS - None

E. REAGENT REQUIREMENTS - None

GUIDELINES FOR
INSTRUCTIONAL PACKAGE WORKSHEET

SUBJECT MATTER: Chemical Laboratory

UNIT OF INSTRUCTION: Summary of Instruction of the Chemical Laboratory

LESSON NUMBER: Total 9

ESTIMATED TIME: 23 Hours

JUSTIFICATION: Chemical analyses are required in the NPDES

ENTRY LEVEL BEHAVIOR: Completion of Module I.

A. INSTRUCTIONAL OBJECTIVE

1. Terminal Behavior - The student will satisfactorily complete the nine units of instruction of the Chemical Laboratory.

2. Conditions - Given a lab with all necessary equipment, classroom instruction and laboratory demonstrations where appropriate.

3. Accepted Performance - Satisfactory performance in the laboratory as measured by the instructor check lists.

B. INSTRUCTIONAL RESOURCES

1. Available Media

Standard Methods for the Examination of Water and Wastewater, 14th ed. (No. 10004), AWWA, APHA, ASCE, WPCF
Laboratory Procedures, Nagan, CWPCA
Safety in the Chemical Laboratory, Norman Steere, CHED
Effluent Monitoring Procedures: Basic Laboratory Skills, CCCC
Safety in the Laboratory, KM
Titration and Its Glassware (51), DuPont, EID
Water Treatment--Water Chemistry (90), DuPont, EID
Laboratory Procedures for Wastewater Treatment Plant Operators, NY Department of Health, HES
Laboratory Procedure for Wastewater Analysis (No. 3), NERWI
Self-Monitoring Procedures: Basic Parameters for Municipal Effluents, EPA-2
Common Laboratory Apparatus (811), CSC
Pipetting Techniques (812), CSC
How to Titrate Using a Buret (8105), CSC
The Buret (Basic Principles) TC-5, EPA-2
Basic Chemistry for Water and Wastewater Personnel--Manual, MI Department of Health, MPH
Winkler Determination of Dissolved Oxygen, EPA-2
Standardization of Sodium Thiosulfate, EPA-2

2. Suggested Media

Video tape presentations of specific laboratory procedures.

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C. INSTRUCTIONAL APPROACH (Sequencing)

1. Preparation for Instruction

Insure that all available media are present in the classroom at the time of instruction.

2. Sequencing

a. Lesson one, Safety - 1 hour
b. Lesson two, Bench Sheets/Notebooks - 1/2 hour
c. Lesson three, Labeling - 1/2 hour
d. Lesson four, Names and Formulas of Compounds - 3 hours
e. Lesson five, Care and Use of Equipment - 2 hours
f. Lesson six, Matter - 2 hours
g. Lesson seven, Solutions - 1 hour
h. Lesson eight, Use of Laboratory Balances - 4 hours
i. Lesson nine, Volumetric Analysis - 9 hours

Note: The Checklist shown on pages 12-13 and 12-14 should be used to evaluate the students' performance.

D. EQUIPMENT AND SUPPLY REQUIREMENTS:

Chemical laboratory equipped with the following:

a. Safety Shower
b. Eye Wash
c. Fire Extinguishers, both Carbon Dioxide and Dry Chemical type
d. Fire Blankets
e. General First Aid Kit
f. Fume Hood
g. Safety glasses
h. There should be safety glasses in the laboratory provided for each student.
i. Notebook for each student
j. One bench sheet for each student, page 32 of Basic Laboratory Skills.
k. Sample labels
l. Lead pencils
m. Grease pencils
n. Vibrogroover
o. Items listed on Checklists I through IV, pages 41-48 of Basic Laboratory Skills

For each pair of students:

a. 3 - 100 ml (or 200 ml) volumetric flasks
b. 2 - 600 ml beakers
c. 1 - Metal trough, ice
d. 1 - Ring and ring stand
e. 1 - 0-120°C thermometer
f. 2 - Porcelain dishes

For instructor demonstration only:

a. 2 - Magnetic stirrers

b. 2 - 400 ml beakers
c. 2 - Magnetic stir bars

One for each pair of students:

a. 15 Gooch crucibles, pre-weighed
b. Analytical balance, double-pan, accuracy 0.1 milligram
c. Electric analytical balance, accuracy 0.1 milligram
d. Triple beam balance, accuracy 1 gram
e. Top loading balance, accuracy .01 gram
f. Filter paper
g. Weighing boats (for class of 15)
h. Weighing bottles (for class of 15)

For each student:

a. 1 - Apron
b. 1 - Beaker, 150-250 ml
c. 1 - Buret, 50 ml
d. 1 - Buret clamp
e. 1 - Graduated cylinder, 25 ml
f. 1 - Graduated cylinder, 100 ml
g. 1 - Evaporating dish
h. 2 - Weighing boats
i. 1 - Volumetric flask, 1 liter
j. 1 - Pipet, 25 ml
k. 1 - Pipet, 10 ml
l. 1 - Storage bottle, 500 ml
m. 1 - Desiccator
n. 1 - Pair safety glasses
o. 1 - Pipet bulb
p. 1 - Titration stand
q. 1 - 125 ml Erlenmyer flask
r. 1 - 10 ml graduated cylinder

Shared equipment:

a. 1 - Analytical balance, 0.1 mg accuracy
b. 1 - Top loading balance, .01 gms accuracy

E. REAGENT REQUIREMENTS:

1% Ferric Chloride Solution
All reagents listed on the following sheets. The instructor may make any desired substitutions, deletions, or additions deemed necessary. About 1/4 of the reagents on each lab table.

Chemical Reagents - Table 1
Chemical Reagents - Table 2
Chemical Reagents - Table 3
Chemical Reagents - Table 4

For class of 15:

60 g Potassium dichromate
1 liter concentrated sulfuric acid
1 lb. commercially available laboratory detergent
Previously prepared potassium hydroxide cleaning solution
5 mls concentrated hydrochloric acid
5 mls concentrated ammonium hydroxide
10 g sodium hydroxide
250 - 300 g technical grade sodium chloride
Sodium chloride (approximately 2 gms per student)
2 liters of distilled water
Stock .75 N Sodium Thiosulfate Pentahydrate solution
Powdered Sodium Thiosulfate Pentahydrate $[NaS_2O_3 \cdot 5H_2O]$
5 ml Chloroform
6 gms Potassium Bi-iodate $[KH(IO_3)_2]$
10 ml Concentrated Sulfuric Acid
5 gms Potassium iodide KI
10 ml Starch solution

GUIDELINES FOR
INSTRUCTIONAL PACKAGE WORKSHEET

SUBJECT MATTER: Chemical Laboratory

UNIT OF INSTRUCTION: Safety

LESSON NUMBER: 1 of 9

ESTIMATED TIME: 1 Hour

JUSTIFICATION: According to state law and the Occupational Safety and Health Act (OSHA), proper safety procedures must be exercised at all times in the laboratory.

ENTRY LEVEL BEHAVIOR: Completion of Module I.

A. INSTRUCTIONAL OBJECTIVE

1. Terminal Behavior - The student will:
   a. Locate the following in the laboratory:
      (1) Safety Shower
      (2) Fire Extinguisher
      (3) Fire Blanket
      (4) Eye Wash
      (5) First Aid Kit and Instruction Sheet
      (6) Fume Hood
   b. Demonstrate the use of the equipment.
   c. Select the proper pieces of equipment, given an emergency situation.
   d. State when safety glasses and laboratory aprons will be used.
2. Conditions - Given a laboratory with all necessary safety equipment and an oral presentation with demonstration of all equipment.
3. Accepted Performance - Satisfactory completion of oral or written quiz (100%).

B. INSTRUCTIONAL RESOURCES

1. Available Media

   Standard Methods for the Examination of Water and Wastewater, 14th ed.
   (No. 10004), AWWA, APHA, ASCE, WPCF
   Laboratory Procedures, Nagano, CWPCA
   Safety in the Chemical Laboratory, Norman Steere, CHED
   Effluent Monitoring Procedures: Basic Laboratory Skills, CCCC
   Safety in the Laboratory, KM

2. Suggested Media

   New film on safety in the Chemistry Laboratory.
   Video Tape on student response of emergency situations.

C. INSTRUCTIONAL APPROACH (Sequencing)

1. Presentation

The student should be in the laboratory for this presentation.

a. Show the locations of the following safety devices and illustrate their use:

   (1) Safety Shower
   (2) Fire Extinguisher
   (3) Fire Blanket
   (4) Eye Wash
   (5) First Aid Kit and Instruction Sheet
   (6) Fume Hood

b. Pose several different emergency situations and tell student how he should handle them. The following examples may be used:

   (1) Your lab partner has splashed sulfuric acid in his eyes.

   Use Eye Wash or Safety Shower.

   (2) You are heating a solution and your shirt catches fire. What do you do?

   Use Fire Extinguisher, Fire Blanket, or Safety Shower.

c. An unannounced emergency situation during the next laboratory sections would be advantageous. Additional examples may be used at this time.

d. The safety regulations of the laboratory should be covered:

   (1) Wear protective goggles or eye glasses at all times in the laboratory.

   (2) Flush corrosive liquid from the eye with plenty of water or, preferably, with sterile isotonic solution.

   (3) If corrosive liquids touch the skin, flood with water. Consult your instructor.

   (4) Do not hold face directly over a container when noting the odor. Instead, fan a little of the vapor toward your nostrils by sweeping your hand over the top of the container.

   (5) For reactions involving poisonous gases, use the hood, which provides suction to remove such gases or vapors.

(6) When diluting any concentrated acid, especially sulfuric acid, pour the acid slowly into the water. Never reverse the order. So much heat is liberated upon solution that steam may form with explosive violence.

(7) Leave reagent bottles on the front chemical table. Bring test tubes or beakers to the shelf for transferring chemicals and carrying them to your desk.

(8) Read the label twice before taking anything from the bottle, noting chemical name, formula, and applicable safety precautions.

(9) Never return unused chemicals to the stock bottle.

(10) Do not insert your own pipets or medicine droppers into the reagent bottles.

(11) Do not lay the stopper of the bottle down in such a manner that it picks up impurities.

(12) Do not heat heavy glassware such as volumetric flasks, graduated cylinders, or bottles; they break easily.

NOTE: These regulations may change from lab to lab.

2. Student Performance and Evaluation

a. Take part in discussion of safety regulations and equipment.

b. Perform as called upon to demonstrate ability to handle an emergency situation.

D. EQUIPMENT AND SUPPLY REQUIREMENTS:

1. Chemical laboratory equipped with the following:

a. Safety Shower
b. Eye Wash
c. Fire Extinguishers, both Carbon Dioxide and Dry Chemical type
d. Fire Blankets
e. General First Aid Kit
f. Fume Hood
g. Safety glasses
h. There should be safety glasses in the laboratory provided for each student.

E. REAGENT REQUIREMENTS: None.

GUIDELINES FOR
INSTRUCTIONAL PACKAGE WORKSHEET

SUBJECT MATTER: Chemical Laboratory

UNIT OF INSTRUCTION: Bench Sheets/Notebooks

LESSON NUMBER: 2 of 9

ESTIMATED TIME: 30 Minutes

JUSTIFICATION: Bench sheets and notebooks are used to keep a permanent record of laboratory information in a logical order.

ENTRY LEVEL BEHAVIOR: Student must have completed registration form.

A. INSTRUCTIONAL OBJECTIVE

1. Terminal Behavior - The student will:

   a. Describe the utility of a laboratory bench sheet:

   b. Complete sample bench sheets with the appropriate information to include:

      (1) Date
      (2) Sample Description
      (3) Equipment number or designation
      (4) Raw data - weight, sample volume, etc.
      (5) Results

   c. Describe information to be included in a general laboratory notebook.

2. Conditions - Given a description of the analysis being performed, sample data, bench sheet, and formulas for calculating the results and instructor assistance.

3. Accepted Performance - Satisfactory response to oral questions and completion of a sample bench sheet.

B. INSTRUCTIONAL RESOURCES

1. Available Media

   Laboratory Procedures, Nagano, CWPCA
   Effluent Monitoring Procedures: Basic Laboratory Skills, CCCC

2. Suggested Media

   None.

C. INSTRUCTIONAL APPROACH (Sequencing)

1. Presentation

   a. Hand out a laboratory notebook.

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b. Emphasize the necessity of up-to-date records.

c. Explain the general information on a bench sheet:

(1) Date
(2) Sample Description
(3) Equipment Designation
(4) Raw Data - weights, sample volume, amount of titrant
(5) Results

d. Complete sample bench sheet (pg. 32) from the information (pg. 33) in the student reference manual.

e. Explain the general information in a notebook:

(1) Date/Procedure/Name
(2) Sample Description
(3) Equipment Designation
(4) Initial and Final Weights
(5) Volume of Liquid
(6) Initial/Final/Elapsed Time
(7) Observations of Abnormal Conditions
(8) Calculation
(9) Results

See sample laboratory record, page 35, student reference manual.

2. Student Performance and Evaluation

a. Take notes on material presented.

b. Complete sample bench sheets.

D. EQUIPMENT AND SUPPLY REQUIREMENTS:

1. Notebook for each student.

2. One bench sheet for each student, page 32 of Basic Laboratory Skills, student reference manual.

E. REAGENT REQUIREMENTS: None.

SAMPLE LABORATORY RECORD

7/22/74 - Standard Potassium Bi-iodate
Solution from D.O. Analysis
(Stock Solution)

Final wt. of beaker	28.2802 g
Initial wt. of beaker	-25.0312 g
	3.2490 g

Volume of water - 1 liter

SAMPLE LABORATORY RECORD

7/22/74 - Settleable Solids Analysis

Primary Influent - Cone #1 Start at 10:25
Stop at 11:25 1 Hour

1 liter sample
Result - 5 ml/1

Final Effluent - Cone #5 Start at 10:30
Stop at 11:30 1 Hour

1 liter sample
Result - no settleable solids

BENCH SHEET B.O.D. DETERMINATIONS

SAMPLE SOURCE & DATE COLLECTED	DATE IN OUT	BOTTLE NO.	INITIAL D.O.	FINAL D.O.	DEPLETION mg/l	% DIL.	B.O.D. mg/l

GUIDELINES FOR
INSTRUCTIONAL PACKAGE WORKSHEETS

SUBJECT MATTER: Chemical Laboratory

UNIT OF INSTRUCTION: Labeling

LESSON NUMBER: 3 of 9

ESTIMATED TIME: 30 Minutes

JUSTIFICATION: All chemical analyses require proper reagent, equipment and labeling.

ENTRY LEVEL BEHAVIOR: Completion of lesson 2, Module 2.

A. INSTRUCTIONAL OBJECTIVE

1. Terminal Behavior - The student will:

   a. Describe the necessity of proper labeling of chemical stock bottles, beakers, flasks, etc.

   b. State the information required on a chemical stock bottle.

   c. State the information required on beakers, flasks, etc., containing in-process chemicals.

   d. Select the proper instrument for writing on porcelain and glass.

   e. Prepare a label for a chemical stock bottle.

2. Conditions - Given an oral presentation with use of labels and a list of information to be put in label format.

3. Accepted Performance - Satisfactory response to oral questions and completion of a label for a chemical stock bottle.

B. INSTRUCTIONAL RESOURCES:

1. Available Media

   Laboratory Procedures, Nagano, CWPCA
   Effluent Monitoring Procedures: Basic Laboratory Skills, CCCC

2. Suggested Media

   None.

C. INSTRUCTIONAL APPROACH (Sequencing)

1. Presentation

   a. Illustrate the purpose of proper labeling of stock bottles, containers and in-process chemicals. Emphasize safety and convenience.

b. Illustrate the following labeling techniques:

(1) Commercial or pre-gummed
(2) Homemade
(3) Use of Grease Pencils
(4) Use of Lead Pencils
(5) Labeling Gooch Crucibles
(6) Labeling MPN Tubes
(7) Use of Water Soluble Markers should be covered at this time.

c. Show the information required on the labels.

CHEMICAL NAME
CHEMICAL FORMULA
CONCENTRATION
(Preservative, if used)
DATE INITIAL

EXAMPLE

SODIUM CHLORIDE
NaCl
0.1 N

7/23/74 J.H.H.

2. Student Performance and Evaluation

a. Take notes on material presented.

b. Complete a sample label as directed.

D. EQUIPMENT AND SUPPLY REQUIREMENTS:

1. Sample labels

2. Lead pencils

3. Grease pencils

4. Vibrogroover

E. REAGENT REQUIREMENTS:

1% Ferric Chloride solution

GUIDELINES FOR
INSTRUCTIONAL PACKAGE WORKSHEET

SUBJECT MATTER: Chemical Laboratory

UNIT OF INSTRUCTION: Names and Formulas of Compounds

LESSON NUMBER: 4 of 9

ESTIMATED TIME: 3 Hours

JUSTIFICATION: In preparation and standardization of reagents, it is necessary to identify chemicals by formula and name.

ENTRY LEVEL BEHAVIOR: Completion of Lesson 3, Module 2.

A. INSTRUCTIONAL OBJECTIVE

1. Terminal Behavior - The student will identify and choose the correct chemicals necessary for an analysis by name and formula.

2. Conditions - Given a laboratory with all necessary chemicals and various lists of consumable supplies.

3. Accepted Performance - Completion of a given check list with 100% accuracy.

B. INSTRUCTIONAL RESOURCES:

1. Available Media

Standard Methods for the Examination of Water and Wastewater, 14th ed. (No. 10004), AWWA, APHA, ASCE, WPCF
Laboratory Procedures for Wastewater Treatment Plant Operators, NY Department of Health, HES
Laboratory Procedure for Wastewater Analysis (No. 3), NEWRI
Self-Monitoring Procedures: Basic Parameters for Municipal Effluents, EPA-2
Effluent Monitoring Procedures: Basic Laboratory Skills, CCCC

2. Suggested Media

None.

C. INSTRUCTIONAL APPROACH (Sequencing)

1. Presentation

a. Cite the importance of using specific chemicals in certain analyses. It must be emphasized that the correct chemical must be chosen for any analysis with 100% accuracy.

b. The importance of the name of the chemical must be stressed, giving the following examples:

(1) Minor spelling variations
(2) The word "anhydrous"
(3) Mesh sizes
(4) The words "dilute" and "concentrated"

c. The importance of the chemical formula must be stressed, giving the following examples:

(1) Significance of letter and subscripts (H_2O)

(2) Meaning of hydration coefficients ($Na_2S_2O_3 \cdot 5H_2O$)

(3) Chemicals that have the same formula but different names such as K_3PO_4:

- (a) Tripotassium phosphate
- (b) Potassium phosphate, tribasic
- (c) Potassium ortho phosphate

(4) Chemicals that have the same name but different formulas, such as:

Sodium Phosphate, monobasic
$Na_2HPO_4 \cdot 2H_2O$
$Ha_2HPO_4 \cdot 7H_2O$
$Ha_2HPO_4 \cdot 12H_2O$

d. The importance of the information contained on a label of a stock bottle must be stressed.

(1) Name
(2) Formula
(3) Cautions - Explosive, Hazards, Fire Hazard, Storage Requirements
(4) Miscellaneous - Purity

e. Students may be rotated from one station to another to insure proper identification of all reagents. A list of suggested reagents is shown on pages 14-18 through 14-21.

2. Student Performance and Evaluation:

a. The student should complete Check Lists I and II as the directions state (pages 14-23 and 14-25).

b. The student should complete Check Lists III and IV as the directions state (pages 14-27 and 14-29).

c. The student should be given a list of consumable supplies from any of the check lists. He will then select the correct stock bottle from a given collection of bottles. It should be re-emphasized that his portion of the lesson must be completed with 100% accuracy.

D. EQUIPMENT AND SUPPLY REQUIREMENTS:

The items listed on Check Lists I through IV and Consummable Supply List I through IV.

E. REAGENT REQUIREMENTS:

All reagents listed on the following sheets:

Chemical Reagents - Table 1
Chemical Reagents - Table 2
Chemical Reagents - Table 3
Chemical Reagents - Table 4

These or similar compounds as stated before may be used.

CHEMICAL REAGENTS

Table #1

$MnSO_4 \cdot H_2O$	Manganous Sulfate Monohydrate
NaI	Sodium Iodide
NaN_3	Sodium Azide
	Soluble Starch (Corn)
NaOH	Sodium Hydroxide (Pellets)
$Na_2S_2O_3 \cdot 5H_2O$	Sodium Thiosulfate Pentahydrate
$KH(IO_3)2$	Potassium Bi-iodate (Potassium Acid Iodate)
KI	Potassium Iodide
$Na_2S_2O_3$	Sodium Thiosulfate Anhydrous
$MgSO_4 \cdot 7H_2O$	Magnesium Sulfate Heptahydrate
$NaIO_3$	Sodium Iodate
KIO_3	Potassium Iodate
NaOH in Solution (6N) Reagent	6N NaOH Sodium Hydroxide

CHEMICAL REAGENTS

Table #2

$MgSO_4 \cdot 7H_2O$	Magnesium Sulfate Heptahydrate
K_2HPO_4	Potassium Phosphate, Dibasic Dipotassium Hydrogen Phosphate
$FeCl_3 \cdot 6H_2O$	Ferric Chloride Hexahydrate
$NaOH + NaI + NaN_3$	Alkaline Iodide - Azide Reagent
$CaCl_2$	Calcium Chloride Anhydrous
$FeCl_2 \cdot 4H_2O$	Ferrous Chloride Tetrahydrate
Na_2HPO_4	Sodium Phosphate, Dibasic, Anhydrous or Disodium Hydrogen Phosphate
KH_2PO_4	Potassium Phosphate, Monobasic, or Potassium Dihydrogen Phosphate
$Na_2HPO_4 \cdot 7H_2O$	Sodium Phosphate, Dibasic, Heptahydrate or Disodium Hydrogen Phosphate Heptahydrate
$Na_2HPO_3 \cdot 5H_2O$	Sodium Phosphite, Dibasic, Pentahydrate or Disodium Hydrogen Phosphite Pentahydrate
$CaCl_2 \cdot 2H_2O$	Calcium Chloride Dihydrate
NH_4Cl	Ammonium Chloride
K_3PO_4	Potassium Phosphate, Tribasic

CHEMICAL REAGENTS

Table #3

KNO_3	Potassium Nitrate
KNO_2	Potassium Nitrite
HCl	Hydrochloric Acid (6N) Dilute
HCl	Hydrochloric Acid Concentrated
$NaAsO_2$	Sodium Arsenite (META)
$Na_2HAsO_4 \cdot 7H_2O$	Sodium Arsenate, Dibasic Heptahydrate or Disodium Hydrogen Arsenate Heptahydrate
$NaCl$	Sodium Chloride
NH_2SO_3H	Sulfamic Acid
$NH_2C_6H_4SO_3H \cdot H_2O$	Sulfanilic Acid

CHEMICAL REAGENTS

Table #4

C_2H_5OH (95%)	Ethyl Alcohol or Ethanol
H_2SO_4 (6N)	Sulfuric Acid (6N) Dilute
H_2SO_4 (18N)	Sulfuric Acid (18N) Concentrated
H_3BO_3	Boric Acid
HgO	Mercuric Oxide; red Mercuric Oxide; yellow
$Na_2S_2O_3$	Sodium Thiosulfate, Anhydrous
NaSCN	Sodium Thiocyanate
NaOH	Sodium Hydroxide (Pellets)
K_2SO_4	Potassium Sulfate
$K_2S_2O_7$	Potassium Pyrosulfate
Methylene Blue, Alcoholic Solution Staining and Powder	
Methyl Blue - Powder	
$C_{15}H_{15}N_3O_2$	Methyl Red - Solution and Powder Solution 0.02% in 60% Alcohol or (p) Para-Dimethylaminoazobenzene Carboxylic Acid

CONSUMABLE SUPPLIES I

1. 480 g manganous sulfate tetrahydrate, $MnSO_4 \cdot 4H_2O$
2. 500 g sodium hydroxide, NaOH
3. 125 g sodium iodide, NaI
4. 10 g sodium azide, NaN_3
5. 4 plastic weighing boats
6. 1 small size spatula
7. 1 medium size spatula
8. 10 g soluble starch
9. 10 ml chloroform
10. 186.15 g sodium thiosulfate pentahydrate, $Na_2S_2O_3 \cdot 5H_2O$
11. 6 g potassium bi-iodate (or potassium biniodate) $KH(IO_3)_2$
12. 3 g potassium iodide, KI
13. 10 ml concentrated sulfuric acid, H_2SO_4
14. Pen or pencil
15. Paper (to record data)

CHECK LIST I

Chemical Names

Place number from "consumable supplies" list by matching name.

_____ a. Sodium Nitrate

_____ b. Sodium Thiosulfate, Anhydrous

_____ c. Sodium Thiosulfate Pentahydrate

_____ d. Carbon Tetrachloride

_____ e. Manganese Hydroxide

_____ f. Manganous Sulfate Tetrahydrate

_____ g. Magnesium Sulfate Heptahydrate

_____ h. Potassium Bichromate

_____ i. Sodium Iodide

_____ j. Sodium Fluoride

_____ k. Potassium Bi-iodate

_____ l. Sodium Sulfite

_____ m. Sodium Thiosulfite

_____ n. Dilute Sulfuric Acid

_____ o. Sodium Azide

_____ p. Sodium Acetate

_____ q. Concentrated Sulfuric Acid

_____ r. Soluble Starch

CONSUMABLE SUPPLIES II

1. Small wad of cotton
2. 10 g potassium dihydrogen phosphate, KH_2PO_4
3. 25 g dipotassium hydrogen phosphate, K_2HPO_4
4. 35 g disodium hydrogen phosphate heptahydrate, $Na_2HPO_4 \cdot 7H_2O$
5. 3 g ammonium chloride, NH_4Cl
6. 25 g magnesium sulfate heptahydrate, $MgSO_4 \cdot 7H_2O$
7. 30 g anhydrous calcium chloride $CaCl_2$
8. 1 g ferric chloride, $FeCl_3$
9. Manganous sulfate solution*, alkaline iodide azide solution*, starch solution*, standard sodium thiosulfate solution*, and concentrated sulfuric acid*.
10. Pen or pencil
11. Paper (for recording data)
12. Grease pencil

*As listed in the EMP on the Winkler Determination of Dissolved Oxygen-Azide Modification.

CHECK LIST II

Chemical Names

Place number from "consumable supplies" list by matching name.

_____ a. Calcium Chloride Dihydrate

_____ b. Sodium Chloride

_____ c. Ammonium Chloride

_____ d. Ferrous Chloride

_____ e. Potassium Dihydrogen Phosphate

_____ f. Magnesium Sulfate Heptahydrate

_____ g. Ammonium Chlorate

_____ h. Calcium Chloride, Anhydrous

_____ i. Ferric Chloride

_____ j. Dipotassium Hydrogen Phosphate

CONSUMABLE SUPPLIES III

1. 721.8 mg anhydrous potassium nitrate, KNO_3
2. 5.0 g sodium arsenite, $NaAsO_2$
3. 1 g brucine sulfate, $(C_{23}H_{26}N_2O_4)_2 \cdot H_2SO_4 \cdot 7H_2O$
4. 0.1 g sulfanilic acid, $NH_2C_6H_4SO_3H \cdot H_2O$
5. 3 ml concentrated hydrochloric acid, HCl
6. 500 ml concentrated sulfuric acid, H_2SO_4
7. 300 g sodium chloride, $NaCl$

CHECK LIST III

Chemical Formulae

Place number from "consumable supplies" list by matching formula.

_____ a. KNO_2

_____ b. KCl

_____ c. HCl

_____ d. KNO_3

_____ e. $NaClO_3$

_____ f. $(C_{24}H_{28}N_2O_4) \cdot H_2SO_4 \cdot 7H_2O$

_____ g. $NaAsO_2$

_____ h. $(C_{23}H_{26}N_2O_4) \cdot H_2SO_4 \cdot 7H_2O$

_____ i. H_3PO_4

_____ j. $NH_2C_6H_4SO_3H \cdot H_2O$

_____ k. H_2SO_4

_____ l. $NaClO$

_____ m. $NaCl$

CONSUMABLE SUPPLIES IV

1. 134 g potassium sulfate, K_2SO_4
2. 200 ml concentrated sulfuric acid, H_2SO_4
3. 2 g red mercuric oxide, HgO
4. 25 ml 6N Sulfuric Acid, H_2SO_4
5. 500 g sodium hydroxide, NaOH
6. 25 g sodium thiosulfate pentahydrate, $Na_2S_2O_3 \cdot 5H_2O$
7. 200 mg methyl red indicator
8. 100 mg methylene blue indicator
9. 150 ml 95% ethyl alcohol, C_2H_5OH
10. 20 g boric acid, H_3BO_3

CHECK LIST IV

Chemical Formulae

Place number from "consumable supplies" list by matching formula.

_____ a. $HBiO_3$

_____ b. $H_2B_4O_7$

_____ c. $NaOH$

_____ d. $Na_2S_2O_3$

_____ e. H_3BO_3

_____ f. CH_3OH

_____ g. $Na_2S_2O_3 \cdot 5H_2O$

_____ h. Hg_2O

_____ i. Hg_2SO_4

_____ j. $KHSO_4$

_____ k. HgO

_____ l. C_2H_5OH

_____ m. $Na_2S_2O_3 \cdot H_2O$

_____ n. K_2SO_4

_____ o. H_2SO_4

_____ p. $Na_2SO_3 \cdot 7H_2O$

GUIDELINES FOR
INSTRUCTIONAL PACKAGE WORKSHEET

SUBJECT MATTER: Chemical Laboratory

UNIT OF INSTRUCTION: Care and Use of Equipment

LESSON NUMBER: 5 of 9

ESTIMATED TIME: 2 Hours

JUSTIFICATION: Chemical analyses requires the preparation and use of specialized equipment.

ENTRY LEVEL BEHAVIOR: Completion of Lessons 1, 3, and 4, Module II.

A. INSTRUCTIONAL OBJECTIVE

1. Terminal Behavior - The student will:

    a. Identify and operate

        (1) Vacuum system
        (2) Laboratory burner
        (3) Fume hood
        (4) Laboratory oven
        (5) Hotplate
        (6) Stirrer

    b. Identify and use specific pieces of glassware as listed on pages 14-34 through 14-37.

    c. Clean glassware as per instruction sheet, page 14-38.

2. Conditions - Given a laboratory with all necessary glassware and equipment, to include an oral presentation with demonstration of all equipment and glassware.

3. Accepted Performance - Performance of operations on equipment specified by instructor with 100% accuracy.

B. INSTRUCTIONAL RESOURCES

1. Available Media

    Standard Methods for the Examination of Water and Wastewater, 14th ed. (No. 10004), AWWA, APHA, ASCE, WPCF
    Titration and Its Glassware (51), DuPont, EID
    Water Treatment--Water Chemistry (90), DuPont, EID
    Laboratory Procedures for Wastewater Treatment Plant Operators, NY Department of Health, HES
    Laboratory Procedure for Wastewater Analysis (No. 3), NERWI
    Self-Monitoring Procedures: Basic Parameters for Municipal Effluents, EPA-2
    Common Laboratory Apparatus (811), CSC
    Pipetting Techniques (812), CSC
    How to Titrate Using a Buret (8105), CSC
    Effluent Monitoring Procedures: Basic Laboratory Skills, CCCC
    The Buret (Basic Principles) TC-5, EPA-2

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2. Suggested Media

Video Cassette demonstrating use of specific laboratory equipment.

C. INSTRUCTIONAL APPROACH (Sequencing)

1. Presentation

a. A comment concerning the format of the Student Reference Manual should be given at this time.

b. Having the student present in the laboratory, demonstrate the use of the following:

(1) Vacuum system. Show the differences between a vacuum pump, aspirator, and house vacuum.
(2) Laboratory burner. Note the different types of burners such as Bunsen, etc., and the various applications of each.

(a) Heating solutions
(b) Working with glass rods and tubing

(3) Fume Hood. Include the type of fume hood, i.e.,

(a) Suction type 50% - 50%
(b) Suction type 100%

Note the importance of utilities such as gas, air vacuum and water present. Also use toxic or explosive chemicals in the fume hood. It should also be pointed out that the fume hood is never to be cluttered with debris.

(4) Laboratory Oven

(a) Temperature Ranges
(b) Use of Asbestos Gloves

(5) Hotplate and Stirrer. Include the fact that these two items may be included in one. Also note that the temperature ranges are in the form of a rheostat rather than a thermometer.

c. All pieces of glassware and hardware listed on pages 14-34 through 14-37 should be shown separately. The purpose and use should be noted.

d. Insure that the student can use the glassware. It should be cleaned according to the procedure given on page 14-38.

2. Student Performance and Evaluation

a. Discuss observations.

b. Perform operations of the above equipment as noted by instructor.

D. EQUIPMENT AND SUPPLY REQUIREMENTS:

General equipment to be demonstrated:

a. Vacuum systems
b. Pump and aspirator
c. Laboratory burner
d. Drying oven
e. Hot plate and stirrer
f. Water still
g. Desiccator
h. 1 - Autoclave
i. 1 - Water Bath
j. 1 - Bench model incubator

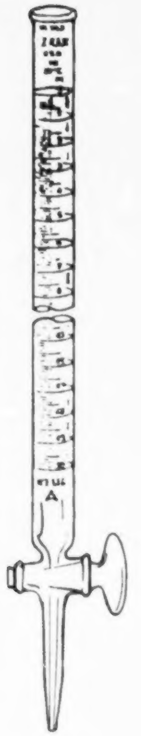
For each pair of students:

a. 1 - 50 ml buret
b. 1 - 10 ml buret
c. 1 - volumetric pipet
d. 1 - Mohr pipet
e. 1 - 110 ml graduated cylinder
f. 1 - 500 ml volumetric flask
g. 1 - 500 ml Erlenmeyer flask
h. 1 - 500 ml side arm filter flask
i. 1 - 400 ml beaker
j. 1 - 60^o long stem glass funnel
k. 1 - powder funnel, plastic
l. 1 - Buchner funnel, 11 cm
m. 1 - Box filter paper
n. 1 - Gooch crucible
o. 4 - 2.5 cm glass fiber filter paper
p. 1 - Box 2.5 cm glass fiber filter paper
q. 1 - Walters adapter
r. 1 - Glass stoppered reagent bottle
s. 1 - Screw top reagent bottle
t. 3 - BOD bottles
u. 1 - Plastic squeeze bottle
v. 1 - Wash bottle
w. 1 - Pair tongs
x. 1 - Buret clamp
y. 1 - Utility clamp
z. 1 - Set culture tubes
aa. 1 - Set dilution bottles
bb. 1 - Inoculation loop

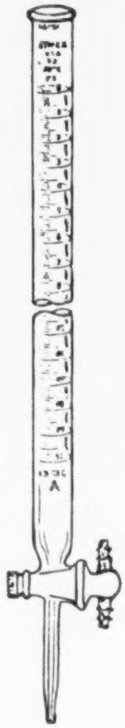
E. REAGENT REQUIREMENTS:

For class of 15:

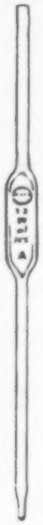
a. 60 g Potassium dichromate
b. 1 liter concentrated sulfuric acid
c. 1 lb. commercially available laboratory detergent
d. Previously prepared potassium hydroxide cleaning solution



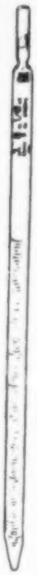
1. STRAIGHT BURET



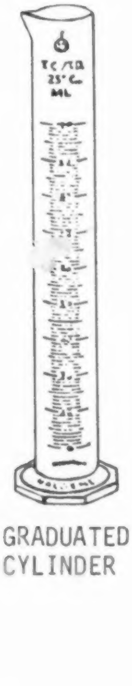
2. STRAIGHT BURET



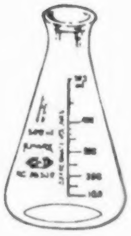
3. VOLUMETRIC PIPET



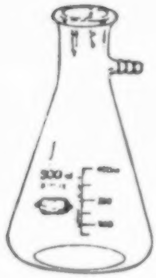
3.1 MOHR PIPET



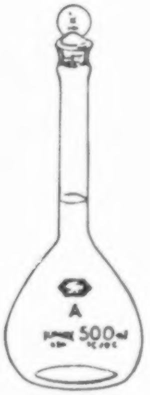
4. GRADUATED CYLINDER



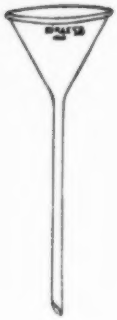
5. ERLENMEYER FLASK



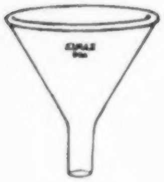
6. SIDE ARM FLASK



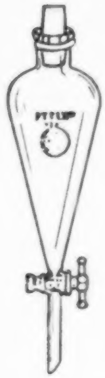
7. VOLUMETRIC FLASK



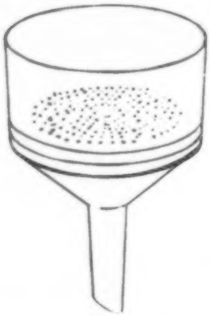
8. CHEMICAL FILTERING FUNNEL



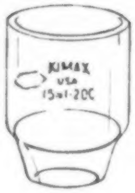
9. POWDER FILLING FUNNEL



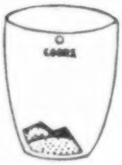
10. SEPARATORY FUNNEL WITH STOPPER AND TEFLON PLUG



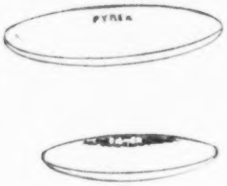
11. BUCHNER FUNNEL



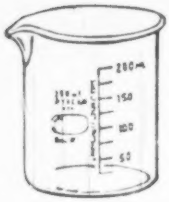
12. GOOCH CRUCIBLE (GLASS)



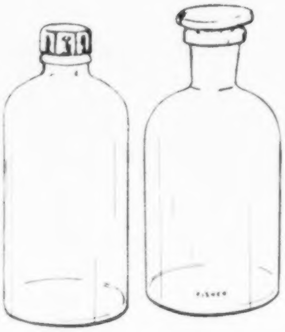
13. GOOCH CRUCIBLE (PORCELAIN)



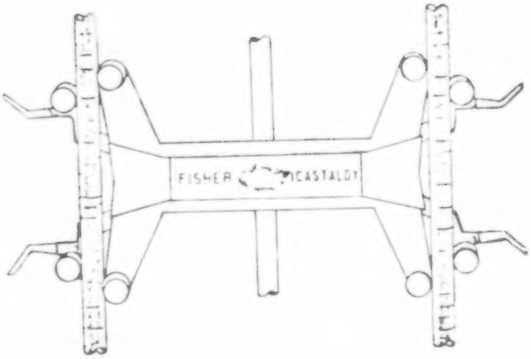
14. WATCH GLASSES


200 ml
150
100
50

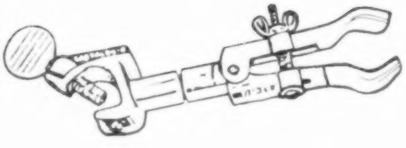
15. BEAKER



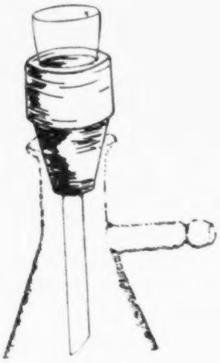
16. REAGENT STORAGE
BOTTLES


FISHER
CASTALOY

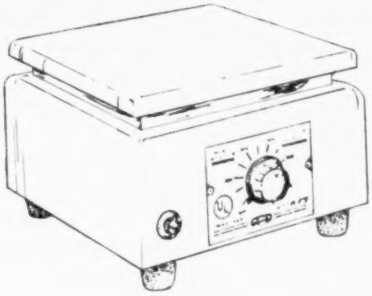
17. DOUBLE BURET CLAMP
(CASTALOY)



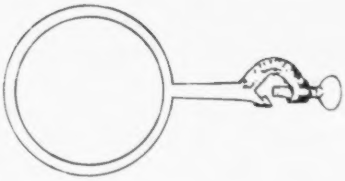
18. CLAMP
(COMBINATION UTILITY)



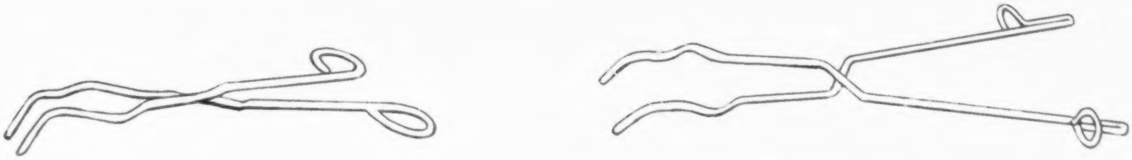
19. WALTER CRUCIBLE HOLDER



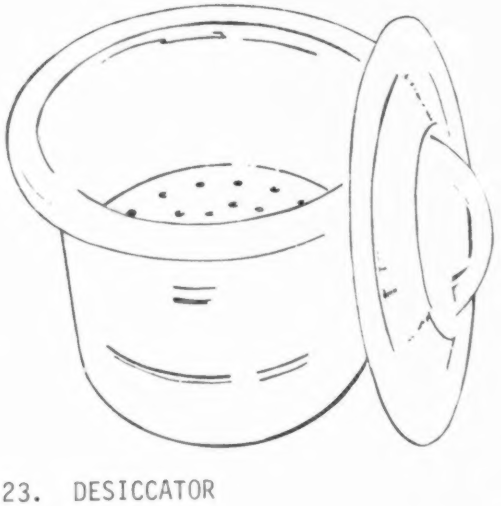
20. HOT PLATE



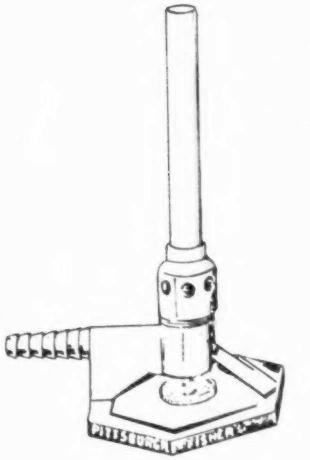
21. RING



22. TONGS



23. DESICCATOR


PITTSBURGH FISHER

24. BUNSEN BURNER

GLASSWARE CLEANING

A piece of volumetric apparatus is sufficiently clean if its surface is uniformly wetted by distilled water. Oily contamination prevents glass walls from being uniformly wetted; drainage is then uneven and delivery is not precise. A general rule is to clean glassware immediately after use, since it is much more difficult to remove chemicals that have been allowed to cake and age.

A volumetric flask, pipet, or buret that no longer drains uniformly is first rinsed thoroughly with tap water. The apparatus is then flushed with cleaning solution (CAUTION!!! - STRONG ACID - USE WITH CARE). The solution should be kept away from the stopcocks so that the grease will not be removed. (A procedure for rinsing a buret with cleaning solution is shown below.) The cleaning solution is then rinsed out thoroughly with distilled water and the outside of the apparatus is wiped dry. To check cleanliness, the equipment is filled with distilled water and allowed to drain. If the water drains from the inner walls in a uniform film, the apparatus is clean; if the film coalesces into streams or droplets, further cleaning is necessary. After being allowed to drain for a few minutes, the equipment is stored with the inside undried. Burets are best stored in an upright position, filled well above the zero mark with distilled water. If this cannot be done in the restricted locker space, it is best to rinse again with cleaning solution just before use. Burets stored empty become contaminated with a grease film that spreads from the stopcock.

1. Place inverted buret in beaker containing cleaning solution.
2. Open stopcock and apply suction with aspirator bulb, drawing solution up into the buret. Fill almost to stopcock. CAUTION! Do not allow cleaning solution to contact the stopcock.
3. Close stopcock and allow solution to stand for a few minutes.
4. Open stopcock to allow cleaning solution to drain back into beaker.

Flushing a Buret with Cleaning Solution

GUIDELINES FOR
INSTRUCTIONAL PACKAGE WORKSHEET

SUBJECT MATTER: Chemical Laboratory

UNIT OF INSTRUCTION: Matter

LESSON NUMBER: 6 of 9

ESTIMATED TIME: 2 Hours

JUSTIFICATION: To better understand the interaction of various chemicals, the makeup of matter is presented.

ENTRY LEVEL BEHAVIOR: Completion of Lessons 1-5, Module V.

A. INSTRUCTIONAL OBJECTIVE

1. Terminal Behavior - The student will:

   a. Give examples of the practical significance of the properties of solids, liquids, and gases.

   b. Note and observe volume change of liquids as the temperature changes.

   c. Note and observe hygroscopic properties of substances.

2. Conditions - Given a lecture with demonstrations with the aid of the Student Reference Manual.

3. Accepted Performance - Satisfactory completion of demonstrations.

B. INSTRUCTIONAL RESOURCES

1. Available Media

   Basic Chemistry for Water and Wastewater Personnel--Manual,
   MI Department of Health, MPH
   Effluent Monitoring Procedures: Basic Laboratory Skills, CCCC

2. Suggested Media

   None.

C. INSTRUCTIONAL APPROACH (Sequencing)

1. Presentation

   a. Develop the concept of physical states of matter and the physical and chemical properties of each.

      The associated demonstration should be performed when stated in the outline.

b. Physical States of Matter

   (1) Matter can exist in three states - solid, liquid, and gas.

   (2) A specific substance can exist in more than one state, for example:

   H_2O, CO_2, N_2, He, Fe, Hg, Cu

   (3) Matter can change spontaneously from one state to another.

c. Pertinent Properties of Each State

   (1) Physical Properties

      (a) Solid

         i. Volume changes with temperature.
         ii. If heated, it may melt, boil, vaporize, decompose or react with substances in the air.
         iii. Significance of these properties in the laboratory:

            aa. Thermal shock when heating or cooling glassware.
            bb. Change in volume of equipment used to measure accurate volumes.
            cc. May emit toxic fumes if heated.

      (b) Liquid

         i. Volume changes as temperature changes.
         ii. Will evaporate with the rate dependent on the specific substance. The boiling point indicates the relative tendency to evaporate.
         iii. Laboratory significance of these properties:

            aa. When accurate volumes of liquids are required, the proper temperature condition must be observed. (Show pipet and volumetric flask.) (Student Demonstration - I, page 14-45.)
            bb. Vapors from some liquids have a bad odor and/or are harmful. These liquids must be used in a well-ventilated room or work must be done in a fume hood.
            cc. Spontaneous evaporation causes increase in pressure inside a closed container, thus popping stoppers.
            dd. Do not store liquids with low boiling points near a source of heat.

      (c) Gas, Vapors, Fumes

         i. Will fill the entire volume available.

ii. Will change volume with temperature if possible, e.g., a balloon.
iii. Will change pressure with temperature change if a volume change is not possible, e.g., Cl_2 in a cylinder.
iv. Practical significance of these properties:

aa. If a liquid evaporates in one part of a room, the gas will fill the room, e.g., acid vapors, solvent vapors. (Instructor Demonstration - I, page 14-43.)
bb. Heating a closed container may cause the container to burst.
cc. Cooling a closed container creates a vacuum inside which may cause container to break or be difficult to open, e.g., cooling a hot liquid in a volumetric flask, cooling in a desiccator.

v. The correct way to check odor of a chemical.

(2) Chemical Properties

(a) Solid

i. Hygroscopic substances.
ii. Increased hazard of spontaneous combustion as particle size decreases.
iii. Reaction with water in the air to form new compounds.
iv. Some solids decompose spontaneously, or if exposed to sunlight for prolonged periods.
v. Practical Significance:

aa. Hygroscopic substances change weight when exposed to wet (humid) air. Therefore, you must use a desiccator for storage. (Student Demonstration - II, page 14-46.)
bb. If chemical stock bottles are left open, the chemical may be affected by the water in the air.
cc. Care must be taken to note the shelf-life of chemicals and observe storage requirements.

(b) Liquids

i. May decompose spontaneously or if exposed to sunlight for prolonged period.
ii. Significance of Property: Observe shelf-life and storage requirements.

(c) Gases, Vapors, Fumes

i. Vapors of different chemicals can react spontaneously (Chlorine and Ammonia HCl and NH_4OH) in the air.

ii. Vapors can mix with air to form an explosive mixture.

iii. Significance of properties:

aa. Keep bottles of chemicals tightly closed. (Instructor Demonstration II, page 14-44.)
bb. Do not store acids and bases next to one another.
cc. Do not work near an open flame with solvents.
dd. Do not smoke in the laboratory.
ee. Keep solvent bottles closed.
ff. Do not pour out large amounts of solvents into open containers.

2. Student Performance and Evaluation

a. View instructor demonstrations and discuss observations.

b. Perform student demonstrations.

c. Take notes on material presented.

D. EQUIPMENT AND SUPPLY REQUIREMENTS:

For each pair of students:

a. 3 - 100 ml (or 200 ml) volumetric flasks
b. 2 - 600 ml beakers
c. 1 - Metal trough, ice
d. 1 - Ring and ring stand
e. 1 - 0 - 120°C thermometer
f. 2 - Porcelain dishes

E. REAGENT REQUIREMENTS:

a. 5 mls concentrated hydrochloric acid
b. 5 mls concentrated ammonium hydroxide
c. 10 g sodium hydroxide

INSTRUCTOR DEMONSTRATION - I DISSIPATION OF GASES

Materials: 1 open bottle of volatile acid or solvent.

Procedure:

1. Open bottle and place in hood at beginning of lecture. Hood must be operating.
2. At time of demonstration, point out open bottle and explain that hood has been on.
3. Turn off hood and measure the time that elapses before the person most distant from the hood smells the vapors.

INSTRUCTOR DEMONSTRATION - II REACTION OF TWO GASES

Materials:

a. 5 ml hydrochloric acid, HCl, concentrated

b. 5 ml ammonium hydroxide, NH_4OH, concentrated

c. 2 porcelain dishes

Procedure:

1. Place HCl in dish.
2. Place NH_4OH in dish.
3. Place dishes side-by-side in a fume hood.
4. Student must note the result.

STUDENT DEMONSTRATION - I VOLUME/TEMPERATURE DEPENDENCE OF LIQUIDS

Materials:

a. 3 - 250 ml (or 200 ml) volumetric flasks

b. Bunsen burner

c. 2 - 500 ml beakers

d. 1 metal trough

e. ice

f. 1 ring and ringstand

g. thermometer

Procedure:

1. Fill a 500 ml beaker with 300 ml of tap water and cool in ice bath.

2. Fill a 500 ml beaker with 300 ml of tap water and heat over a Bunsen burner to 80°C (use thermometer).

3. Fill each volumetric flask to the base of the neck:

    a. 1 flask with cold water
    b. 1 flask with hot water
    c. 1 flask with room temperature water

    Use a squeeze-bottle to fill to the full mark.

4. Let all flasks come to room temperature and observe the level of the water in the flask.

STUDENT DEMONSTRATION - II HYGROSCOPIC SUBSTANCES

Materials:

a. 4 sodium hydroxide (NaOH) pellets in screw-cap bottle.

b. Porcelain dish containing dry sewage solids (stored in desiccator)

c. 1 clean, dry porcelain dish

Procedure:

1. Pour pellets into clean, dry porcelain dish and note appearance immediately.
2. Remove dish with sewage solids from desiccator and note appearance immediately.
3. Note appearance of substance after 15 minutes.

GUIDELINES FOR
INSTRUCTIONAL PACKAGE WORKSHEET

SUBJECT MATTER: Chemical Laboratory

UNIT OF INSTRUCTION: Solutions

LESSON NUMBER: 7 of 9

ESTIMATED TIME: 1-1/2 Hours

JUSTIFICATION: Chemical analyses requires the use of several types of solutions.

ENTRY LEVEL BEHAVIOR: Completion of Lessons 1 through 6 of Module II.

A. INSTRUCTIONAL OBJECTIVE

1. Terminal Behavior - The student will:

   a. List the general properties of solutions.

   b. State the effect of temperature on the solubility of solids and gases in liquids.

   c. State possible effects of a dissolving chemical on the temperature of the solution.

   d. Calculate the concentration of a solution in mg/l or ppm, given the weight of solute in grams or milligrams and the volume of solvent in liters (or milliliters).

   e. Recognize the letters N and M following numbers as indicating that the number is describing concentration.

2. Conditions - Given an oral presentation and a laboratory with all necessary chemicals and equipment.

3. Accepted Performance - Satisfactory response to oral questions and completion of concentration problems.

B. INSTRUCTIONAL RESOURCES

1. Available Media

   Basic Chemistry for Water and Wastewater Personnel--Manual,
   MI Department of Health, MPH
   Effluent Monitoring Procedures: Basic Laboratory Skills, CCCC

2. Suggested Media

   Video cassettes to demonstrate specific properties of solutions.

C. INSTRUCTIONAL APPROACH (Sequencing)

1. Presentation

   a. Using the three physical states of matter, show the nine (9) types of solutions. Emphasize that only gas/liquid, liquid/liquid, and solid/liquid are applicable to the parameter being studied.

b. List the general properties of solutions as follows:

(1) Saturated, unsaturated and supersaturated.
(2) Mixture (define).
(3) Homogeneous-(salt and water).
(4) Heterogeneous-(nonhomogeneous), (water and sand).

(3) and (4) should be demonstrated at this time.

c. List the specific properties of solutions.

(1) Effect of temperature on gas/liquid solution. Heating decreases solubility; cooling increased solubility. Use dissolved oxygen and carbon dioxide (CO_2) as examples.

(2) Effect of temperature on solid/liquid and liquid/liquid solutions. Heating/cooling may increase or decrease solubility. Use $CuSO_4 \cdot 7H_2O$ or KNO_3 to illustrate an increase in solubility by heating. Use $MnSO_4 \cdot 7H_2O$ or $MnSO_4 \cdot H_2O$ to illustrate a decrease in solubility by heating.

(3) Effect of the dissolving process on temperature of the solution. A solid/liquid solution such as NaOH/water will increase the temperature of the solution. A $Na_2S_2O_3 \cdot 5H_2O$ solution will decrease the temperature of the solution. Emphasize safety aspects such as: Use of pyrex glass, and fume hoods.

d. Develop the concept of concentration by following the outline.

(1) The concept of "concentration"

(a) A description of the amount of solid, liquid or gas dissolved in a given volume of water.

(b) Formal definition is: The weight of solid (liquid or gas) per volume of water.

(c) Mathematical description is:

$$C = \frac{W}{V}$$

(d) Give three examples by first giving written description of solution, then give mathematical description. All weights are in mg and all volumes in liters. All examples should ultimately have same concentration. Leave examples on chalkboard.

(2) The formal statement of concentration.

(a) The accepted way to describe concentration is with a simplified number and the units mg/liter or g/liter.

(b) Explain by using the illustrations on the chalkboard and by dividing numerator by denominator. The student will then see that all of the solutions were actually the same concentration.

EXAMPLES:

	Description of Solution	Basic Math Description of Concentration	Formal Concentration
I.	250 mg of NaCl dissolved in 1 liter of water	$\frac{250 \text{ mg}}{1 \text{ liter}}$	250 mg/liter
II.	500 mg of NaCl dissolved in 2 liters of water	$\frac{500 \text{ mg}}{2 \text{ liters}}$	250 mg/liter
III.	125 mg of NaCl dissolved in .5 liter of water	$\frac{125 \text{ mg}}{.5 \text{ liter}}$	250 mg/liter

(c) The relationship between the units mg/liter and ppm.

(d) Other units of concentration such as Normality (N) and Molarity (M).

2. Student Performance and Evaluation

a. View instructor demonstration and discuss observations.

b. Take notes on material presented.

c. Respond to oral questions as presented.

D. EQUIPMENT AND SUPPLY REQUIREMENTS:

For instructor demonstration only:

a. 2 - Magnetic stirrers
b. 2 - 400 ml beakers
c. 2 - Magnetic stir bars

E. REAGENT REQUIREMENTS:

250 - 300 g technical grade sodium chloride

GUIDELINES FOR
INSTRUCTIONAL PACKAGE WORKSHEET

SUBJECT MATTER: Chemical Laboratory

UNIT OF INSTRUCTION: Use of Laboratory Balances

LESSON NUMBER: 8 of 9

ESTIMATED TIME: 4 Hours

JUSTIFICATION: Chemical analyses requires the use of several types of balances.

ENTRY LEVEL BEHAVIOR: Completion of Lessons 1 through 7 of Module II.

A. INSTRUCTIONAL OBJECTIVE

1. Terminal Behavior - The student will:
   a. Identify and use a triple-beam balance with a range of 0-100 g with an accuracy of ± 0.01 g.

   b. Identify and use an electric, top-loading balance with an accuracy of ± 0.01 g.

   c. Identify and use a double-pan analytical balance with an accuracy of ± 0.0001 g.

   d. Identify and use an automatic analytical balance with an accuracy of ± 0.0001 g.

   e. State precautions applicable to the care and use of all balances.

   f. The above should be performed with Gooch crucibles and applicable chemicals.

2. Conditions - Given any of the balances with appropriate reference material.

3. Accepted Performance - Weighing:

   a. A Gooch crucible to ± 0.0005 g using the double-pan analytical and single-pan analytical balance.

   b. A salt sample to ± 0.05 g using the top-loading electric balance.

B. INSTRUCTIONAL RESOURCES

1. Available Media

   Laboratory Procedures for Wastewater Treatment Plant Operators, NY Dept. Health, HES
   Laboratory Procedures, Nagano, CWPCA
   Effluent Monitoring Procedures: Basic Laboratory Skills, CCCC

2. Suggested Media

   None.

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C. INSTRUCTIONAL APPROACH (Sequencing)

1. Presentation

a. General Balance Rules

(1) Treat all balances gently.
(2) If the balance has an "arrest" mechanism, the balance must be in the "arrest position" when putting on or taking off substances to be weighed or the weights themselves.
(3) Before weighing, insure that the balance is level.
(4) During a given experiment, use the same balance for all weighings.
(5) Never weigh an object which is hot or even warm.
(6) Never put chemicals directly on the balance pan. Use a piece of filter paper or an appropriately sized, clean, dry beaker.
(7) If the balance is enclosed in a glass case, keep the case closed when taking the final weight.
(8) Always "zero" the balance before beginning the weighing procedure.
(9) After finishing a weighing procedure, remove all weights and put the "arrest mechanism" in position.

b. Types of Balances

(1) Use of Triple-Beam Balance (± 0.01 g accuracy)

(a) Leveling
(b) Finding zero-point by examining the "swing"
(c) Weighing procedure-demonstration with beaker
(d) Effect of air currents
(e) Number of decimal places in the result

(2) Use of Analytical Balance (± 0.0001 g accuracy)

(a) Leveling
(b) Parts of the balance - rider, chain, beam arrest, pan arrest
(c) Putting balance in "ready status"
(d) Finding the zero-point by examining the swing. (If zero-point is more than 3 divisions from center, adjust with adjusting screws on the beam.)
(e) Weighing procedure (demonstrate with beaker)

- Object on left pan, weights on right pan
- Keep door open while adding (or subtracting) weights on pan
- Use beam arrest at all times
- Add weight to pan to the nearest 1 gram
- Record digits to the right of decimal place
- Close door

- Determine weight to the nearest tenth of a gram with rider with beam arrest off and using only the pan arrest when moving the rider
- Record digit in tenth's position
- With all arrest mechanisms off, move the chain so that the indicator swings evenly about the zero-point
  (The pan arrest may be used to "quiet" the swing)
- Record the hundredth's and thousandth's digit from the movable metal strip (or dial or pointer) associated with the chain. Use the zero mark on the Vernier as the reference
- Record the ten-thousandth's digit from the Vernier scale
  (Explain, if necessary, what a Vernier scale does and how to read it. Give extra work on reading Vernier scale.)

(f) Restate precautions on care and use of this balance.

(3) Use of Single-Pan, Automatic, Analytical Balance

(Present such material as is necessary according to the Operation and Maintenance Manual for the specific balance.

(4) Use of Top-Loading, Electric Balance

(Present appropriate material from Operation and Maintenance Manual specific to the balance.)

c. The importance of reporting weights to the correct number of decimal places should be emphasized. It should also be noted that the number of decimal places reflects the accuracy of the balance.

d. All crucibles to be used in this exercise should be preweighed by the instructor. The salt samples should be prepared in numbered vials (at least two per student will be needed).

2. Student Performance and Evaluation

a. View instructor demonstrations and discuss observations.

b. Weigh a Gooch crucible.

c. Determine the weight of a given quantity of NaCl by weighing into a beaker.

d. Obtain required accuracy, either ± 0.05 g or ± 0.0005 g depending on the type of balance used.

D. EQUIPMENT AND SUPPLY REQUIREMENTS:

One for each pair of students:

a. 15 Gooch crucibles, pre-weighed
b. Analytical balance, double-pan, accuracy 0.1 milligram
c. Electric analytical balance, accuracy 0.1 milligram
d. Triple beam balance, accuracy 1 gram
e. Top loading balance, accuracy .01 gram
f. Filter paper
g. Weighing boats (for class of 15)
h. Weighing bottles (for class of 15)

E. REAGENT REQUIREMENTS:

Enough for one for each student:

Sodium chloride (approximately 2 gms per student)

GUIDELINES TO
INSTRUCTIONAL PACKAGE WORKSHEET

SUBJECT MATTER: Chemical Laboratory

UNIT OF INSTRUCTION: Volumetric Analysis

LESSON NUMBER: 9 of 9

ESTIMATED TIME: 9 Hours

JUSTIFICATION: Chemical analyses require the preparation and use of several types of standard solutions.

ENTRY LEVEL BEHAVIOR: Completion of Lessons 1 through 8 of Module II.

A. INSTRUCTIONAL OBJECTIVE

1. Terminal Behavior - The student will accurately prepare:

   a. 0.0375N Potassium Biiodate primary standard solution

   b. 0.0375 N (approximate) Sodium Thiosulfate solution

   c. 10% by volume Sulfuric Acid solution

   d. Magnesium Sulfate (Nutrient) solution

2. Conditions - Given an oral presentation with all the necessary laboratory reagents and equipment.

3. Accepted Performance

   a. Satisfactory preparation of all reagents as specified by the instructor.

   b. Able to attain acceptable precision in a titration analysis.

B. INSTRUCTIONAL RESOURCES

1. Available Media

   Standard Methods for the Examination of Water and Wastewater, 14th Ed., AWWA, APHA, ASCE, WPCF
   Laboratory Procedures, Nagano, CWPCA
   Safety in the Chemical Laboratory, Norman Steere, CHED
   Effluent Monitoring Procedures: Basic Laboratory Skills, CCCC
   Winkler Determination of Dissolved Oxygen, EPA-2, EPA
   Standardization of Sodium Thiosulfate, EPA-2, EPA

2. Suggested Media

   CCTV cassettes on solution preparation.

C. INSTRUCTIONAL APPROACH (Sequencing)

1. Presentation

   a. Define volumetric analysis. The concentration of a solution is determined by the measurement of volumes.

b. Analyze the steps in a volumetric analysis:

   (1) Preparation of the reagent
   (2) Preparation of the primary standard
   (3) Standardization of the reagent

   A sodium thiosulfate standard solution will be prepared and standardized with a potassium bi-iodate standard. (See page 102, A.2., through page 106, B.2.8. of the Student Reference Manual.)

c. All points covered in the specific procedure should be re-emphasized.

d. Common errors in a volumetric determination:

   (1) Uncertainty in purity of the primary standard.
   (2) Decomposition of the solution in standard.
   (3) Changes in temperature.
   (4) Careless laboratory technique.
   (5) Errors in weighing.
   (6) Mechanical losses of solution during titration or during transfer of solutions.
   (7) Improper mixing of solutions.
   (8) Dirty burets, pipets and other similar apparatus.

e. The correct procedure for titration should be re-emphazised at this time.

f. In order to insure students' ability in solution preparation, one or more of the reagents of the Dissolved Oxygen and/or Biochemical Oxygen Demand analysis should be prepared. These may be found in EMP Manual, BOD Analysis.

g. A 0.75N stock solution of sodium thiosulfate should be available. If time permits, a sample Dissolved Oxygen determination should be performed by the instructor using the students' reagents.

2. Student Performance and Evaluation

   a. Take notes on material presented.

   b. Discuss observations and demonstrations.

   c. Prepare a standard solution and primary standard as directed.

   d. Prepare a reagent for the BOD determination as directed.

D. EQUIPMENT AND SUPPLY REQUIREMENTS:

1. For each student:

   a. 1 apron
   b. 1 beaker, 150-250 ml
   c. 1 buret, 50 ml
   d. 1 buret clamp
   e. 1 graduated cylinder, 25 ml
   f. 1 graduated cylinder, 100 ml
   g. 1 evaporating dish
   h. 2 weighing boats
   i. 1 volumetric flask, 1 liter
   j. 1 pipet, 25 ml
   k. 1 pipet, 10 ml
   l. 1 storage bottle, 500 ml
   m. 1 desiccator
   n. 1 pair safety glasses
   o. 1 pipet bulb
   p. 1 titration stand
   q. 1 125 ml Erlenmeyer flask
   r. 1 10 ml graduated cylinder

2. Shared equipment:

   a. 1 analytical balance, 0.1 ml accuracy
   b. 1 top loading balance, .01 gms accuracy

E. REAGENT REQUIREMENTS:

   a. 2 liters of distilled water
   b. stock .75 N Sodium Thiosulfate Pentahydrate solution
   c. powdered Sodium Thiosulfate Pentahydrate $[NaS_2O_3 \cdot 5H_2O]$
   d. 5 ml Chloroform
   e. 6 gms Potassium Bi-iodate $[KH(IO_3)_2]$
   f. 10 ml concentrated Sulfuric Acid
   g. 5 gms Potassium iodide KI
   h. 10 ml Starch solution

GUIDELINES TO
INSTRUCTIONAL PACKAGE WORKSHEET

SUBJECT MATTER: Microbiology

UNIT OF INSTRUCTION: Summary of Instruction on Microbiology

LESSON NUMBER: Total of 2

ESTIMATED TIME: 4 Hours

JUSTIFICATION: The NPDES requires bacteriological analyses.

ENTRY LEVEL BEHAVIOR: Completion of Module II.

A. INSTRUCTIONAL OBJECTIVE

1. Terminal Behavior - The student will satisfactorily complete the two units of instruction on Microbiology.

2. Conditions - Given a lab with all necessary equipment, classroom instruction, and laboratory demonstrations where appropriate.

3. Accepted Performance - Satisfactory performance in the laboratory as measured by the instructor check lists.

B. INSTRUCTIONAL RESOURCES

1. Available Media

   Water Pollution Microbiology, R. Mitchell, WI
   Self-Monitoring Procedures: Basic Parameters for Municipal Effluents, EPA-2
   Current Practices in Water Microbiology, EPA
   Effluent Monitoring Procedures: Basic Laboratory Skills, CCCC

2. Suggested Media

   Audio visual material on general microbiological techniques
   Audio visual material to show relationship to wastewater treatment

C. INSTRUCTIONAL APPROACH (Sequencing)

1. Presentation

   Insure that all available media are present in the classroom at the time of instruction.

2. Sequencing

   a. Lesson One, General Laboratory - 1 hour
   b. Lesson Two, Laboratory - 3 hours
   c. Evaluation Sheet, Page 12-15 should be used for this Module.

D. EQUIPMENT AND SUPPLY REQUIREMENTS:

1. For each student:

   a. 1 inoculating loop
   b. 1 10 ml pipet
   c. 1 dilution bottle
   d. 6 fermentation tubes
   e. 1 Bunsen burner

2. Shared equipment:

   a. Autoclave
   b. Incubator
   c. Hot air oven
   d. Water bath

E. REAGENT REQUIREMENTS:

   a. 3 gms dehydrated EC broth
   b. 200 ml distilled water

GUIDELINES TO
INSTRUCTIONAL PACKAGE WORKSHEET

SUBJECT MATTER: Microbiology

UNIT OF INSTRUCTION: General Introduction

LESSON NUMBER: 1 of 2

ESTIMATED TIME: 1 Hour

JUSTIFICATION: An understanding of the fecal coliform test requires a general introduction to Microbiology.

ENTRY LEVEL BEHAVIOR: Completion of Module II.

A. INSTRUCTIONAL OBJECTIVE

1. Terminal Behavior - The student will:
    a. Define the following terms: microbiology, pathogenic, bacteria, and coliform.

    b. State why coliform organisms are used as indicator organisms.

2. Conditions - Oral presentation using the Student Reference Manual.

3. Accepted Performance - Satisfactory completion of written quiz (4/5 on closed book; 5/5 on open book).

B. INSTRUCTIONAL RESOURCES

1. Available Media

    Water Pollution Microbiology, R. Mitchell, WI
    Self-Monitoring Procedures: Basic Parameters for Municipal Effluents, EPA-2, EPA
    Current Practices in Water Microbiology, EPA

2. Suggested Media

    AV material to show relationship to wastewater treatment.

C. INSTRUCTIONAL APPROACH (Sequencing)

1. Presentation

    The instructor should describe the following, placing particular emphasis on the relationship to effluent monitoring:

    a. Biology
        (1) Macrobiology
        (2) Microbiology

The study of small, living organisms; microscopic organisms such as bacteria, yeasts, molds, algae, and protozoa, need microscope to see. Refer to SRM for size comparisons.

(a) Microbe - a microscopic organism.

(b) Germ - generally refers to any micro-organism but especially one that is pathogenic.

(c) Pathogenic - disease-producing.

(d) Microbe and germ are probably synonymous with bacteria.

(e) Bacteria - the basic unit of plant life; single-celled microorganisms; widely distributed in nature; can be round, rod-shaped or spiral-shaped.

b. Bacteriology

(1) Description of bacteria - Bacteria are described by size and shape and by growth, temperature, and oxygen requirements.

(2) Impression is that all bacteria are harmful; in fact, the great majority of bacteria are necessary for the existence of living things and only a few are harmful to man. Give examples of those that are beneficial.

(3) The pathogenic bacteria:

(a) Can be the causative agent of such diseases as cholera, typhoid fever, and dysentary.

(b) These diseases are associated with the gastrointestinal tract, and therefore, fecal material.

(c) The discharge of treated and/or untreated waste material, fecal in origin, can contain pathogenic organisms.

(d) We take the helpful bacteria for granted; it is the pathogen about which we are concerned.

(4) Identification of pathogens:

(a) Most pathogens are extremely difficult to isolate and identify.

(b) We have indicator organisms - the coliform group of bacteria.

(c) The coliform group of bacteria - those of fecal origin - can indicate the degree of fecal contamination and the presence or absence of pathogenic organisms.

(d) Can identify the coliforms and all bacteria by their shape and how they act biochemically.

(e) See how they react biochemically by growing them in an environment they enjoy.

(f) The environment in which we grow them is called media.

c. Summary

(1) Microbiology is the study of microscopic organisms.

(2) The main concern of the wastewater treatment plant lab technician is the presence of fecal contamination.

(3) Can check for presence of fecal contamination by checking for coliforms.

2. Student Performance and Evaluation

a. Take notes on material presented.

b. Respond to oral questions as presented.

c. Completion of written quiz (page 12-15).

D. EQUIPMENT AND SUPPLY REQUIREMENTS:

None.

E. REAGENT REQUIREMENTS:

None.

GUIDELINES FOR
INSTRUCTIONAL PACKAGE WORKSHEET

SUBJECT MATTER: Microbiology

UNIT OF INSTRUCTION: Laboratory Techniques

LESSON NUMBER: 2 of 2

ESTIMATED TIME: 3 Hours

JUSTIFICATION: Correct performance of the fecal coliform test requires proper microbiological laboratory techniques.

ENTRY LEVEL BEHAVIOR: Completion of Lesson 1, Module III.

A. INSTRUCTIONAL OBJECTIVE

1. Terminal Behavior - The student will:

   Describe and demonstrate methods of maintaining aseptic conditions with respect to inoculating loop, mouth pipet and sample transfer.

   a. Prepare E.C. media.

   b. Prepare fermentation tubes.

   c. Use inoculating loop.

2. Conditions - Given necessary laboratory equipment, classroom instruction and demonstrations of all equipment and procedures to be used.

3. Accepted Performance - Instructor approval on preparation of media and tubes and use of inoculating loop.

B. INSTRUCTIONAL RESOURCES

1. Available Media

   Water Pollution Microbiology, R. Mitchell, WI
   Self-Monitoring Procedures: Basic Parameters for Municipal Effluents, EPA-2, EPA
   Current Practices in Water Microbiology, EPA
   Effluent Monitoring Procedures: Basic Laboratory Skills, CCCC

2. Suggested Media

   None.

C. INSTRUCTIONAL APPROACH (Sequencing)

1. Presentation

   a. Introduce Microbiology Laboratory by using video tape and illustrating lab equipment.

      (1) Autoclave
      (2) Incubator

Preceding page blank

(3) Hot air oven
(4) Water bath
(5) Inoculating loop
(6) Pipet
(7) Dilution bottle
(8) Fermentation tubes
(9) Bunsen burner

b. Discuss disinfection and sterilization and the importance of maintaining aseptic conditions.

(1) Disinfection - the killing or removing of agents which cause disease.

(2) Sterilization - the destruction of absolutely all life.

Examples of physical agents for disinfection and sterilization:

(a) Fire - the best sterilizing agent - Bunsen burner

(b) Steam - for surface disinfection and where penetration is desired.

i.) Surface - no pressure, need contact for 30-40 minutes.

ii.) Steam generated in closed tank such as autoclave - contact for 20 minutes at 16 psi and 15 minutes at 20 psi - Sterilization.

(c) Boiling - will disinfect in a few seconds; sterilization will require contact of 15 to 20 minutes.

(d) Dry Heat - does not penetrate as well as steam and less effective than wet heat; 300°F will require 3 to 4 times as long as boiling.

(e) Cold - not a disinfectant; it does prevent multiplication of bacteria; some pathogenic bacteria, such as typhoid, are stored this way.

D. EQUIPMENT AND SUPPLY REQUIREMENTS:

1. For each student:

a. 1 inoculating loop
b. 1 10 ml pipet
c. 1 dilution bottle
d. 6 fermentation tubes
e. 1 Bunsen burner

2. Shared equipment:

   a. Autoclave
   b. Incubator
   c. Hot air oven
   d. Water bath

E. REAGENT REQUIREMENTS:

   a. 3 gms dehydrated EC broth
   b. 200 ml distilled water

GUIDELINES FOR
INSTRUCTIONAL PACKAGE WORKSHEET

SUBJECT MATTER: Laboratory Inventory

UNIT OF INSTRUCTION: Ordering Equipment and Supplies

LESSON NUMBER: 1 of 1

ESTIMATED TIME: 1 Hour

JUSTIFICATION: Proper inventory procedures are necessary for any chemical laboratory.

ENTRY LEVEL BEHAVIOR: Completion of Modules II and III.

A. INSTRUCTIONAL OBJECTIVE

1. Terminal Behavior - Given a list of chemicals and equipment, the student will be able to locate appropriate items in a scientific catalog. (See pages 16-3 through 16-8.)

2. Conditions - Given chemical catalogs.

3. Accepted Performance - Completion of order form.

B. INSTRUCTIONAL RESOURCES

1. Available Media

   Several Scientific Catalogs

2. Suggested Media

   None.

C. INSTRUCTIONAL APPROACH (Sequencing)

1. Presentation

   a. Show utility of choosing proper equipment and supplies.

   b. Define and illustrate:

      (1) Capital equipment

      (2) Reusable supplies

      (3) Consumable supplies

   c. Use specific catalogs to show equipment and chemicals.

   d. Have students complete an order form given a sample list (pages 16-3 through 16-8).

2. Student Performance and Evaluation

   a. Discuss problems of ordering supplies.

   b. Complete a sample order form.

D. EQUIPMENT AND SUPPLY REQUIREMENTS:

None.

E. REAGENT REQUIREMENTS:

None.

EFFLUENT MONITORING PROCEDURE: Fecal Coliform Test by the Multiple Dilution Tube Method

General description of equipment and supplies used in the test analysis.

Capital Equipment

Autoclave, providing uniform temperatures up to and including 121°C; equipped with an accurate thermometer, pressure gauges, and saturated steam power lines; and capable of reaching required temperature within 30 minutes.

Balance, 0.1 g sensitivity at load 160 g.

Air incubator to operate at 35°C ± 0.2°C and to accomodate tube racks as described separately.

Oven, *hot-air sterilizing; to give uniform temperatures and, with suitable thermometer, to register accurately in range of 160-180°C.

pH meter, accurate to at least 0.1 pH unit with standard pH reference solution(s).

Water distillation apparatus (glass or block tin) or source of distilled water suitable for bacteriological culture media.

Reusable Supplies

Apron or coat suitable for laboratory.

Baskets, wire for discarded cultures.

Bottles, dilution*, 6-oz. screw caps with 99 ml volume-level etched on one side.

Bottles, sample*, 250 ml (6-8 oz.) wide mouth glass-stoppered preferred.

Bottle, squeeze type, with disinfecting solution.

Burner, gas, Bunsen burner type.

Cans, pipet, aluminum or steel; not copper. (If plastic or other type of disposal pipet is used, this item is unnecessary.)

Metal caps* to fit 20 x 150 mm culture tubes.

Jar, to receive discarded pipets.

Inoculation loop, 3 mm diameter loop of nichrome or platinum-iridium wire, 26 B&S gauge, in holder.

Pipets*, 1 ml with 0.1 ml graduations, Mohr type preferred, sterile, cotton-plugged, glass or disposal plastic.

Racks, culture type*, 10 x 5 openings, to accept tubes at least 20 mm in diameter

Sponge, for cleaning desk top

Tubes, culture*, 20 x 150 mm

Tubes, fermentation*, 12 x 75 mm vials to be inverted in culture tubes

Supplies Used Up in the Analysis (must be replaced when stocks get low)

Distilled water, suitable for bacteriological cultures (note distillation apparatus required in capital equipment)

EC Broth, Dehydrated (recommended purchase 1 lb units)

Lactose Lauryl Sulfate Tryptose Broth, Dehydrated (recommend purchase of 1 lb units)

Potassium Dihydrogen Phosphate (KH_2PO_4) (recommend purchase of 1 lb units)

Disinfectant, for bench tops. (Use household bleach solution prepared according to instructions on bottle.)

Wax pencils (recommend soft wax equivalent to Blaisdell 169T)

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*Since the items ordered vary according to the daily analysis schedule, they are needed in quantities requiring space allowances which cannot be specified here. As a rule of thumb, space/size or quantity requirements should be at least three times the normal daily requirements. For further information on specifications for equipment and supplies, see the Microbiology Section of the current edition of "Standard Methods for the Examination of Water and Wastewater."

NAME ____________________

ASSIGNMENT #1: Equipment and Supplies for Fecal Coliform Test
Multiple Dilution Tube Method

Assume that you are responsible for the effluent monitoring tests for your treatment plant, which has an average daily flow of 18 mgd. In addition, you conduct the effluent monitoring tests for two small plants in your vicinity, each of which has an average daily flow between 1 and 4.99 mgd.

Prepare a purchase request, based on information in catalogs made available to you by your instructor, for the items shown below. (The amount should be enough to last one year. The size of fixed equipment should be appropriate to the amount of lab work required, assuming that the sampling schedules will be set up to have the work from the surrounding laboratories come in on a scheduled basis to provide an even daily workload.)

Order: Wax pencils
EC Broth (dehydrated)
Fermentation Tube Assemblies
Autoclave

Minimum information in the purchase request should itentify--

a. Yourself, as the originator of the request
b. The name of the item(s) requested
c. The size and number of the item(s)
d. The cost per unit and the total cost for the item
e. The name of the catalog from which you obtained the item, the stock number of each item selected from the catalog, and any other identifying information that the purchasing officer should have.

NAME ______________________

ASSIGNMENT #2: Equipment and Supplies for the Determination of Five-Day Biochemical Oxygen Demand (BOD)

Assume that you are responsible for the effluent monitoring tests for your treatment plant, which has an average daily flow of 18 mgd. In addition, you conduct the effluent monitoring tests for two small plants in your vicinity, each of which has an average daily flow between 1 and 4.99 mgd.

Prepare a purchase request, based on information in catalogs made available to you by your instructor, for the items shown below. (The amount should be enough to last one year. The size of fixed equipment should be appropriate to the amount of lab work required; assume that the sampling schedules will be set up to have the work from the surrounding laboratories come in on a scheduled basis to provide an even daily workload.)

Order: 300 ml BOD bottles
20 ml volumetric pipets
Incubator
Dipotassium hydrogen phosphate (K_2HPO_4)

Minimum information in the purchase request should identify--

a. Yourself, as the originator of the request
b. The name of the item(s) requested
c. The size, and number of the item(s)
d. The cost per unit and the total cost for the item
e. The name of the catalog for which you obtained the item, the stock number of each item selected from the catalog, and any other identifying information that the purchasing officer should have.

EFFLUENT MONITORING PROCEDURE: Determination of Five-day Biochemical Oxygen Demand (BOD_5)

General Description of Equipment Used in the Process

A. Capital

1. Trip balance, 100 g capacity
2. Still, or other source of distilled water
3. Incubator capable of maintaining a temperature of 20°C ± 1°C, and large enough to hold four 300 ml BOD bottles and a 3 liter jug or bottle

B. Reusable

1. Brushes (for cleaning glassware)
2. Brush (for cleaning balance)
3. Laboratory apron
4. Safety glasses
5. One spatula (medium size)
6. One distilled water plastic squeeze bottle
7. One pen or pencil
8. One notebook (for recording data)
9. Seven plastic weighing boats (2-3 inches square)
10. Sponges (for cleaning of laboratory table tops)
11. One 3 liter jug or bottle with narrow neck
12. One powder funnel, about 3 inch diameter
13. One 1 liter volumetric flask
14. Four 1 liter glass stoppered bottles
15. Two 1 liter graduated cylinders
16. One siphon (long enough for use with the 1 liter graduated cylinder)
17. Four 1 ml volumetric pipets
18. One 10 ml volumetric pipet
19. One 20 ml volumetric pipet
20. One plunger type mixer (for use with the 1 liter graduated cylinder)
21. Four 300 ml BOD bottles
22. Equipment for doing a Winkler DO determination-azide modification, See EMP CH.O.EMP. 1c.7.77, Winkler Determination of Dissolved Oxygen-Azide Modification, or
23. One dissolved oxygen meter, See EMP CH.O.do.EMP.1c.8.76, Determination of Dissolved Oxygen Using a Dissolved Oxygen Meter

C. Consumable

1. Small wad of cotton (to plug the 3 liter jug or bottle)
2. 8.5 g of potassium dihydrogen phosphate, KH_2PO_4
3. 21.75 g of dipotassium hydrogen phosphate, K_2HPO_4
4. 33.4 g of disodium hydrogen phosphate heptahydrate, $Na_2HPO_4 \cdot 7H_2O$
5. 1.7 g of ammonium chloride, NH_4Cl
6. 22.5 g of magnesium sulfate heptahydrate, $MgSO_4 \cdot 7H_2O$
7. 27.5 g of anhydrous calcium chloride, $CaCl_2$

C. Consumable (Continued)

8. 0.25 g of ferric chloride, $FeCl_3$
9. Reagents for doing a Winkler DO determination-azide modification, see EMP CH.O.EMP.1c.7.77, Winkler Determination of Dissolved Oxygen-Azide Modification
10. Reagents for use with a dissolved oxygen meter, see EMP CH.O.do.EMP.1c.8.76, Determination of Dissolved Oxygen Using a Dissolved Oxygen Meter
11. Concentrated sulfuric acid, H_2SO_4
12. Potassium dichromate, $K_2Cr_2O_7$
13. Soap

(Items 11, 12, and 13 are for cleaning glassware. The quantities needed will therefore vary.)

All reagents should be of high quality such as certified, ACS, or analyzed grade.

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